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MICRO-ENVIRONMENTAL STUDIES

SECTION II D

BIOLOGY

The attached document, a report of Biological Studies prepared by Woodward-Envicon, Inc., Biological Consultants, is the result of the first quarter (August through November, 1974) of biological baseline activities on Federal Oil Shale Lease Tract, "C-b". Included in the reporting for this quarter are the following studies:

Terrestrial Wildlife Studies

Big Game, Big Game-Livestock Competition, Medium-Size Mammals, Large Predators, Small Mammals, Birds, Reptiles & Amphibians, Arthropods and Microarthropods.

Aquatic Studies

Fish, Benthos, Periphyton, Water Qaulity, Plankton and Primary Productivity.

Terrestrial Vegetation Studies

Vegetation Mapping, Floristic Studies, Phytosociological Studies, Additional Sampling, Productivity Studies, Phenological Studies, Decomposition Studies, Successional Studies, Analytical Methods.

Dendrochronology and Dendroclimatology Studies

Soils and Soils Productivity Assessment Studies

This report is prefaced by an enlarged Table of Contents which is designed to direct the reader to specific areas of interest.

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+ Indicates that study is in preliminary phase

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FIRST QUARTERLY REPORT: AUGUST - NOVEMBER 1974

BIOLOGICAL BASELINE STUDIES
Federal Oil Shale Lease
TRACT C-b

prepared for

Atlantic Richfield Company, Operator

December 1974

WOODWARD-ENVICON, INC./Subsidiary of Woodward-Clyde Consultants

Biological baseline studies for Tract C-b and vicinity were initiated in August 1974. The purpose of this two-year program is to meet the Federal Oil Shale Lease Environmental Stipulations and to provide a generalized ecosystem model for the area of study.

In this task Woodward-Envicon's biological staff is being assisted by the following:

- Stoecker-Keammerer & Associates (vegetation, medium-sized mammals, and big game movement)
- Ecology Consultants, Inc. (avifauna)
- Dr. Tyler A. Woolley (soil arthropods)
- Mr. Michael Glenn (dendrochronology and dendroclimatology)
- Dr. James Ward (limnology).

Federal Oil Shale Lease Tract C-b is in Rio Blanco County approximately 18 miles west of Rio Blanco, Colorado, and south of Piceance Creek in the Piceance Creek Basin. The study area includes this tract (about 5100 acres) and an additional area covering at least 1 mile beyond the tract. The biological investigations have been divided into four general areas:

- Terrestrial Wildlife Studies
- Aquatic Studies
- Terrestrial Vegetation Studies
- Dendrochronology and Dendroclimatology.

This first quarterly report represents the work carried out from August to November 1974 and presents methodology, field data, and a

preliminary discussion of the findings. More definitive evaluations will be made as the studies progress. A summary of these studies to date follows.

TERRESTRIAL WILDLIFE STUDIES

The wildlife program includes studies of big game; predators; medium-sized mammals; amphibians and reptiles; and arboreal, soil, and ground arthropods. Study areas for these animal groups are located at random in and around the tract; study areas for the smaller groups are also located contiguous to the vegetation study sites for purposes of integration.

The importance of Tract C-b to big game will be evaluated through an analysis of movements, numbers, habitat utilization, and mortality. These studies have been initiated.

This fall (1974) deer began moving to their winter range in early October, and by November large numbers were observed daily grazing in the hay meadows of Willow and Piceance creeks. Deer leave their bedding grounds and cover sites in the late afternoon and early evening and move north off Tract C-b to the hay meadows to graze. By daybreak they retreat to their bedding sites. Deer make extensive use of the meadows around Tract C-b.

Medium-sized mammals are fairly wide-ranging and widely distributed. There are no species unique to this area. A wide variety of these mammals are found in and around Tract C-b, including badgers, porcupines, skunks, raccoons, cottontail rabbits, jackrabbits, and marmots. The more abundant species (cottontail rabbits, jackrabbits, and possibly marmots, raccoons, and skunks) are being monitored by track counts, observation, and sign. In addition, predator-prey relationships are being studied.

The most abundant of the medium-sized mammals is the cottontail rabbit. This species is an important prey for predators and raptors. The major predators and raptors observed this summer and fall (coyote, bobcat, red-tailed hawk, sparrow hawk, etc.) prey extensively on cottontails, voles, chipmunks, and wood rats. Dead mule deer are also important food items, especially for the coyotes.

The small mammals include the shrews, mice, voles, wood rats, and chipmunks. Population dynamics studies for the more abundant species commenced in August 1974 at two permanent study sites representing the chained pinyon-juniper woodland and the pinyon-juniper woodland. To date, the species composition in the chained pinyon-juniper is slightly greater than that in the pinyon-juniper. The increased habitat due to felled pinyon and juniper trees and increased understory growth probably accounts for the difference.

Smaller grids located in all habitat types on Tract C-b are being monitored to assess the relative abundance and the habitat preferences of small mammals. These results, along with the results from the larger grids, show that the dominant rodent is the deer mouse, followed by the chipmunks. These species also occur in most habitats. The remainder of the species account for less than 10 percent of the total number of rodents. In the hay meadows, however, the voles are the dominant species.

As a result of initial field investigations, a checklist of bird species utilizing habitats on the tract has been developed.

Preliminary results indicate that the birds encountered on Tract C-b are basically those species expected to be present during early and late fall on the basis of published information from northwestern Colorado and northeastern Utah. However, some species were observed that normally reside at higher elevations.

Initial results demonstrate that a sparse and uneven pattern of bird distribution is expected to occur during fall. Of the 19 species

recorded during early fall, the most abundant species within the pinyon-juniper and sagebrush habitats were the mountain bluebird, Townsend's solitaire, and yellow-rumped warbler. Black-capped chickadees, mountain chickadees, and ruby-crowned kinglets dominated the mountain shrub community. The riparian area was inhabited principally by mourning doves, white-crowned sparrows, and song sparrows. By late November, most migrants had left the area, leaving only those species which are expected to winter on the tract. Only 10 species were observed in late November. The pinyon-juniper and sagebrush-rabbitbrush habitats were inhabited principally by the white-breasted nuthatch, American robin, Townsend's solitaire, and northern shrike. Typical birds found in the riparian meadow habitat during late November included the American robin, starling, white-crowned sparrow, and song sparrow.

Qualitative field observations at a variety of locations documented the presence of an additional 26 species during both sampling periods. Pinyon jays, gray-headed juncos, and pine siskins were the most frequently encountered species of the pinyon-juniper woodlands during early fall. The late fall census accounted for pinyon jays and mountain chickadees in this community. Sagebrush-grass areas were favored by horned larks during early October. At this time of year the riparian habitats supported a community which included black-billed magpies, western meadowlarks, red-winged blackbirds, Brewer's blackbirds, starlings, white-crowned sparrows, and song sparrows.

Waterfowl observation stations were established. The dominant waterfowl noted were mallards, green-winged teal, and blue-winged teal.

A nocturnal survey revealed four owl species.

No quantitative data have been gathered for the reptiles and amphibians at the present time. However, the presence of the sagebrush lizard, short-horned lizard, and leopard frog has been noted.

The relative abundance of arthropod populations will be compared within the major vegetation types for ground, flying, and arboreal species. This is done with the use of pit-can traps and sweep nets. Comparisons of five common shrubs were made between the chained pinyon-juniper woodland and the pinyon-juniper woodland in the fall of 1974. These results indicate a more diverse ground arthropod fauna in the chained site. Arthropod collections from shrubs are not sufficient at present for comparative purposes, but their diversity appears less than the diversity of ground arthropods.

Soil arthropods are being studied in four major vegetation types (chained pinyon-juniper woodland, pinyon-juniper woodland, plateau sagebrush, and valley sagebrush). Soil arthropods are collected, identified, and enumerated from grasses, shrubs, and bare soil. Where species designations are possible, they are noted. The fall samples show that the most abundant groups are the Prostigmata mites, followed by Oribatid mites. Miscellaneous groups (worms, spiders, pseudoscorpions, larval insects, etc.) are third in abundance.

AQUATIC STUDIES

Collections of aquatic organisms were begun in August 1974. These include fish, benthos, periphyton, and plankton. Collection of water samples for bacteriological assays and for nutrient and common mineral analyses were also commenced at the same time.

A total of 18 sampling sites were established to include the existing major aquatic habitats. Seven sample sites were along the Piceance Creek upstream and downstream from Tract C-b, 9 along both Willow Creek and Stewart Gulch, and 2 along the White River.

Fish are stunned with a backpack shocker and collected for identification, weight and length measurements, and tagging. The benthos are sampled with an Ekman grab and a Surber stream sampler. Periphyton

samples are collected from slides suspended in the water column, and water quality samples are placed in polycube containers and returned to the laboratory for analysis.

Three species of trout have been collected to date (rainbow, brook, and brown); the most abundant fish, however, is the mountain sucker. The brook trout is the second most abundant fish, but the population is concentrated in lower Stewart Lake and the channel that drains the lake. Preliminary data suggest that suitable habitat varies along Piceance Creek, and fish abundance reflects habitat suitability.

The benthic samples to date suggest a high production of fish food organisms (mayflies, damselflies, dragonflies, etc.) in upper Stewart and Willow lakes. The poorest benthic species composition occurs downstream of Tract C-b in areas with mud and clay substrate.

The periphyton are represented by green algae, diatoms, blue-green algae, and aquatic vascular plants.

Water quality analyses for nutrients, common minerals, bacteriological bioassays, and physical parameters have been completed for August to October. The carbonate, bicarbonate, and sulfate anions, and the calcium, sodium, and magnesium cations have slowly increased since August. The increase and decrease in coliform levels closely coincides with the presence and absence of grazing cattle in the meadows along Piceance Creek.

TERRESTRIAL VEGETATION STUDIES

Six study sites have been permanently located on Tract C-b to gather data on structural, compositional, and functional aspects of the vegetation. The study sites are placed in plateau sagebrush, valley sagebrush, chained pinyon-juniper woodland, and pinyon-juniper woodland. The ongoing studies include the flora, phytosociology, productivity, decompo-

sition, phenology, and successional status of the vegetation. In addition, a vegetation map of the tract and its environs is being produced to delineate the identifiable vegetation types.

Fourteen vegetation types are recognizable in the study area. To date, approximately 190 species have been identified. All plants collected are stored in a herbarium. The phytosociological data gathered at the permanent study sites during the past late summer and fall indicate considerable variation within the chained pinyon-juniper woodland and also within the pinyon-juniper woodland. The dominant species in the chained pinyon-juniper woodland are the shrubs, big sagebrush, mountain mahogany, and antelope bitterbrush, and the saplings of pinyon pine, Utah juniper, and Rocky Mountain juniper. The pinyon-juniper woodland is dominated by the trees, pinyon pine, Utah juniper, and Rocky Mountain juniper. Where a shrub understory exists, serviceberry, snowberry, and mountain mahogany are abundant.

The plateau sagebrush vegetation type differs compositionally from the valley sagebrush type by the absence of winterfat and rubber rabbitbrush. These sagebrush communities may have replaced native grasslands following the introduction of cattle and sheep by early homesteaders.

The fenced and open plots at each study site show high similarity to each other in the structural and compositional aspects of the vegetation. Meaningful future comparisons will be possible because of this feature.

Productivity, phenology, and decomposition studies have been designed and initial work has been completed, so data gathering can begin in 1975. Successional studies and gradient analyses will be conducted in 1975. To date, no rare or endangered plant species have been located on Tract C-b.

DENDOCHRONOLOGY AND DENDROCLIMATOLOGY

This study on Tract C-b is intended to date growth-ring increments of pinyon pine. These data are correlated with climatic information to study variability in past and present climates. Five stands of pinyon pine have been cored, tree rings measured, and a composite chronology prepared. These tree-ring measurements, properly dated and matched with available climatic information, will be analyzed with a computer program designed to identify significant trends or cycles in past climatic conditions, from which present and future cycles can be inferred. Several trees on Tract C-b have been dated to approximately 600 years.

SOILS AND PRODUCTIVITY ASSESSMENT

A soils survey will be conducted by Woodward-Thorfinnson & Associates, Inc., beginning in the spring of 1975. This survey is expected to be completed by the end of September 1975.

Arrangements for greenhouse studies for determining the productivity of various soil types on Tract C-b are in progress. These studies are expected to be completed by June 1975.

I

TERRESTRIAL WILDLIFE STUDIES

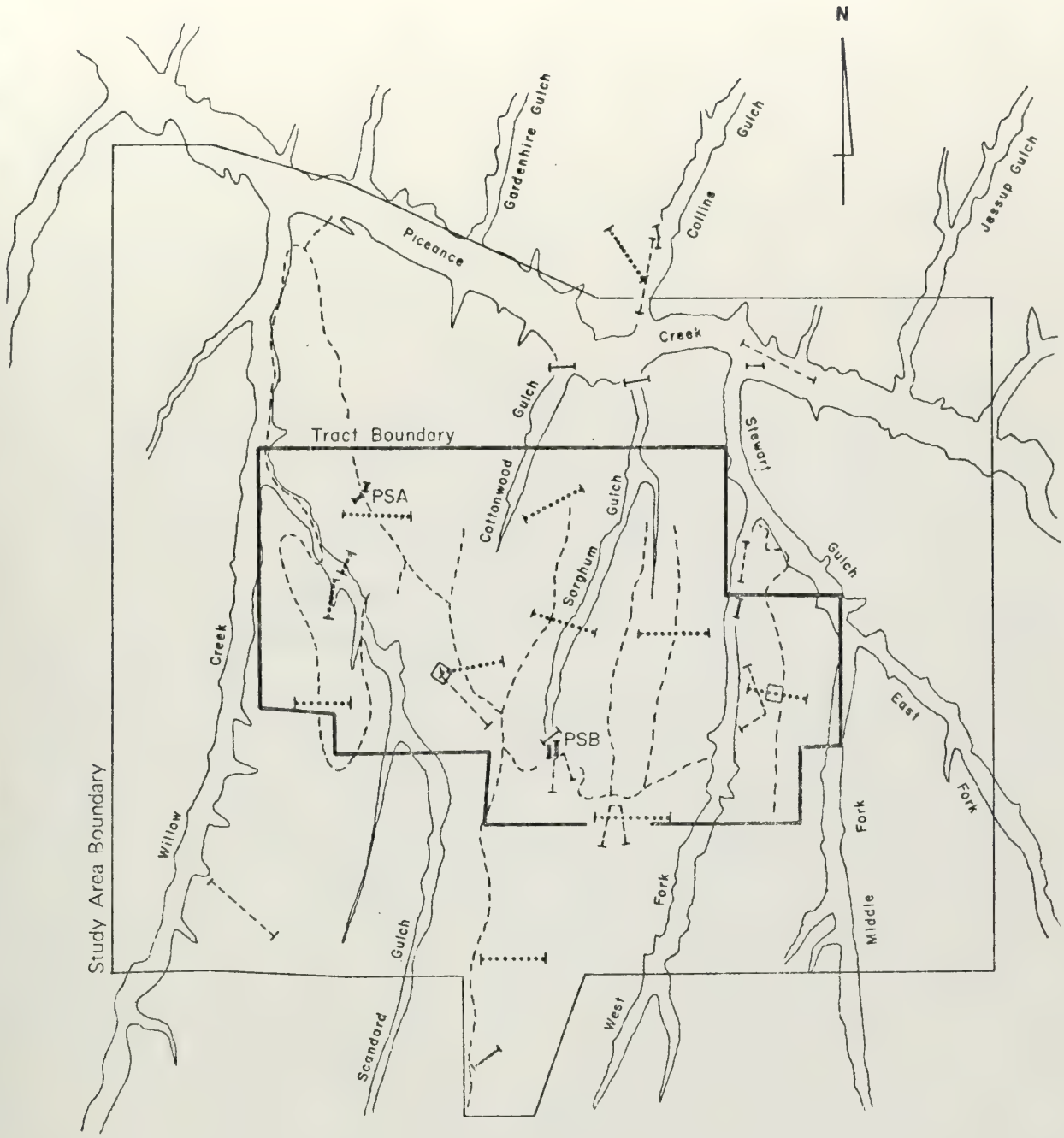
The wildlife studies on Tract C-b are designed to provide the following baseline ecological information:

- species lists of the major groups of vertebrate and invertebrate animals
- distribution and abundance of these species
- structure and dynamics of selected animal populations
- functional aspects of these populations to produce a generalized ecosystem model.

Because animal species on and around Tract C-b are diverse and include both vertebrates and invertebrates, and because time and resources do not allow a detailed investigation of all species, the emphasis in these studies is on selected conspicuous and important animal groups.

The ecosystem approach to these studies is sufficiently rigorous that the results will be in compliance with the Oil Shale Lease Environmental Stipulations concerning fauna (Federal Register, Vol. 38, No. 230, sec. 1c, 2d). The wildlife studies are quantitative to some degree as well as qualitative, and comparisons with future work in this area will be possible.

This first quarterly report summarizes initial findings of the field investigations from August to November of 1974. A preliminary literature review has been done, and some of the sources are cited in the text to illustrate, clarify, or substantiate methodology, results, or tentative conclusions. Figure I-1 shows the location of the terrestrial wildlife study areas for Tract C-b.



KEY:

PSA = Parasite sample - A
PSB = Parasite sample - B
= Roads
= Ornithological study transect
= Satellite animal trapping transect
= Small mammal parasite sampling site.
= Deer pellet and browse transect.
= Small mammal trapping grid; reptile and arthropod pit-cans.

0 1 2 3 miles

0 1 2 3 kilometers

Figure I-1. TERRESTRIAL WILDLIFE STUDY AREAS

METHODOLOGY

The methods used for the terrestrial field studies are described below.

Big Game

The distribution and abundance of big game, mainly mule deer, in and around Tract C-b are being monitored by several techniques, including track counts, road counts, aerial counts (by aerial observation and with aerial photographs), pellet-group counts, and winter mortality counts.

The relative abundance of deer in the four habitat types within the C-b area is estimated by track counts and by road counts. It is intended that these methods be continued for future deer monitoring. Track counts (which also serve to monitor medium-size mammals) are conducted by counting the tracks in 20 quadrats, measuring 4 square meters each, placed at 25-meter intervals. These quadrats are located along linear landscape features (old roads and dry creek beds, for example) in order to have a suitable surface for reading tracks, and for ease of access (Figure I-2). Each quadrat is raked free of large debris, and fine dry soil is sifted over the quadrat if necessary. Quadrats are prepared in the evening, and counts are made the next morning. The frequency of occurrence of each species is recorded for each 20-station transect.

Road counts are conducted at night and late evening. Night road counts have been abandoned, however, since comparatively few deer were observed. Evening road counts are conducted by recording the deer observed in 1-mile intervals along an established length of road. The 1-mile locations (Figures I-3 and I-4) are approximate and will be modified somewhat to incorporate significant topographic and habitat features.

During times of snow cover it is possible to more accurately describe deer movements and areas of deer concentrations, since tracks are more

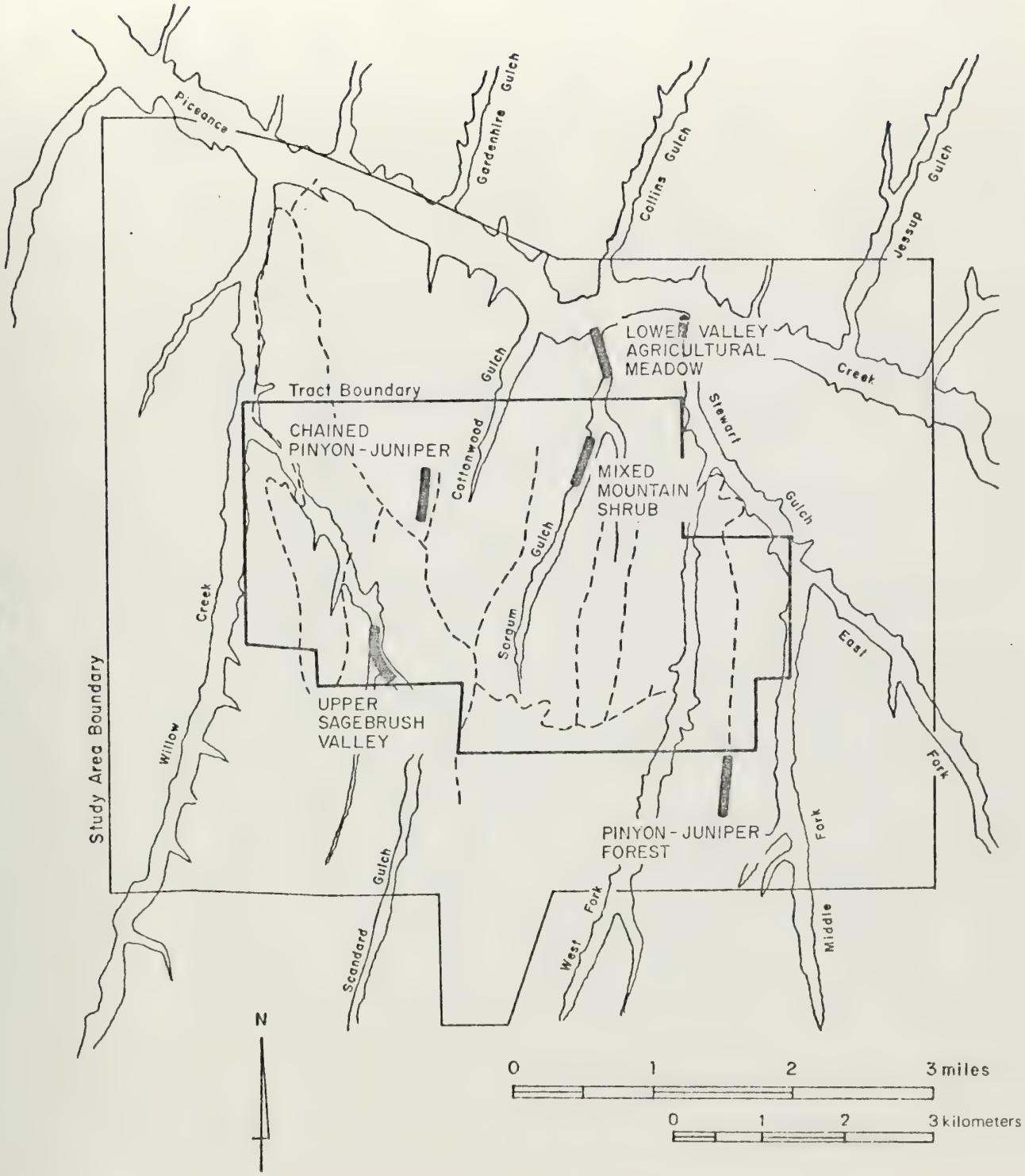


Figure I-2. LOCATIONS OF TRACK COUNT TRANSECTS

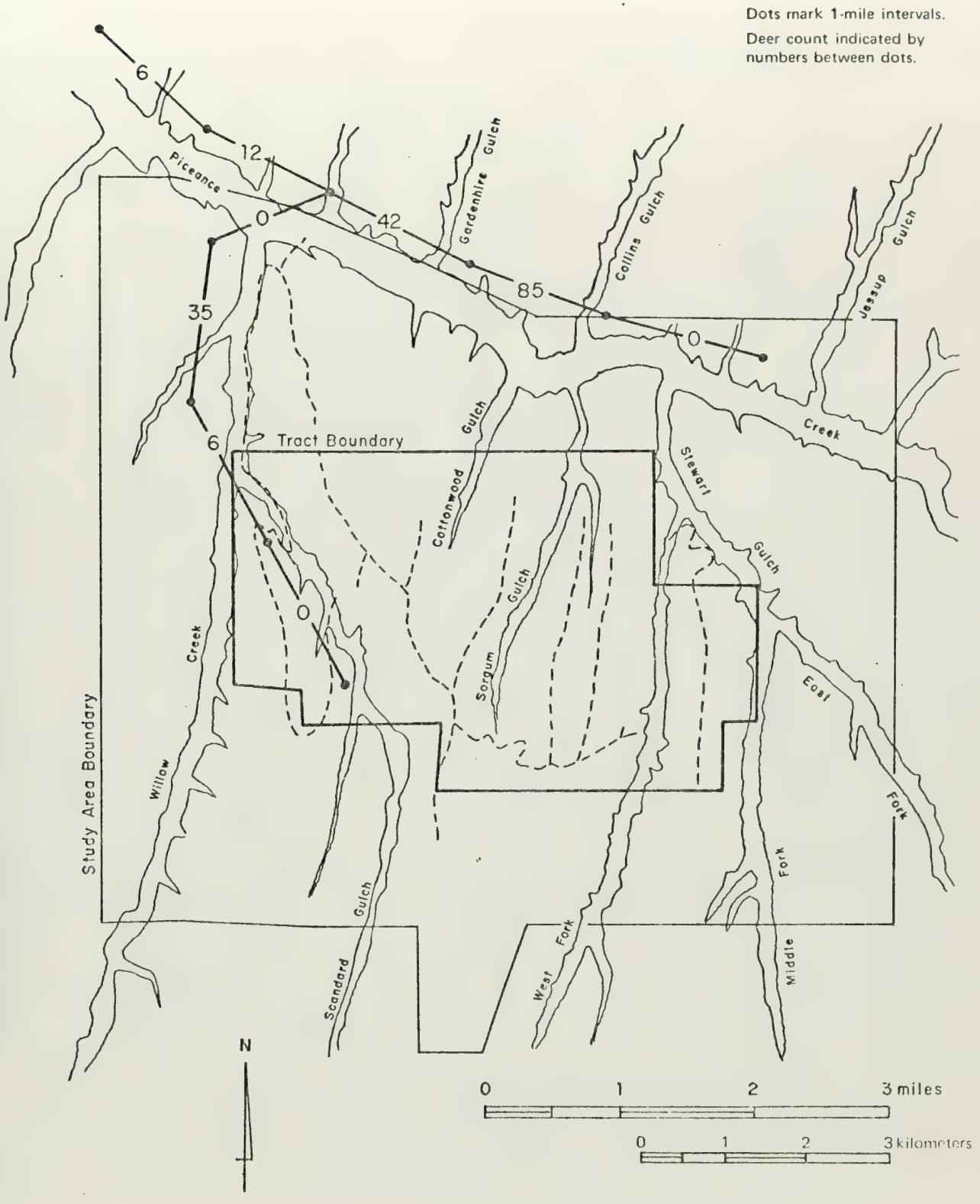


Figure I-3. DEER CONCENTRATIONS, NOVEMBER 12, 1974

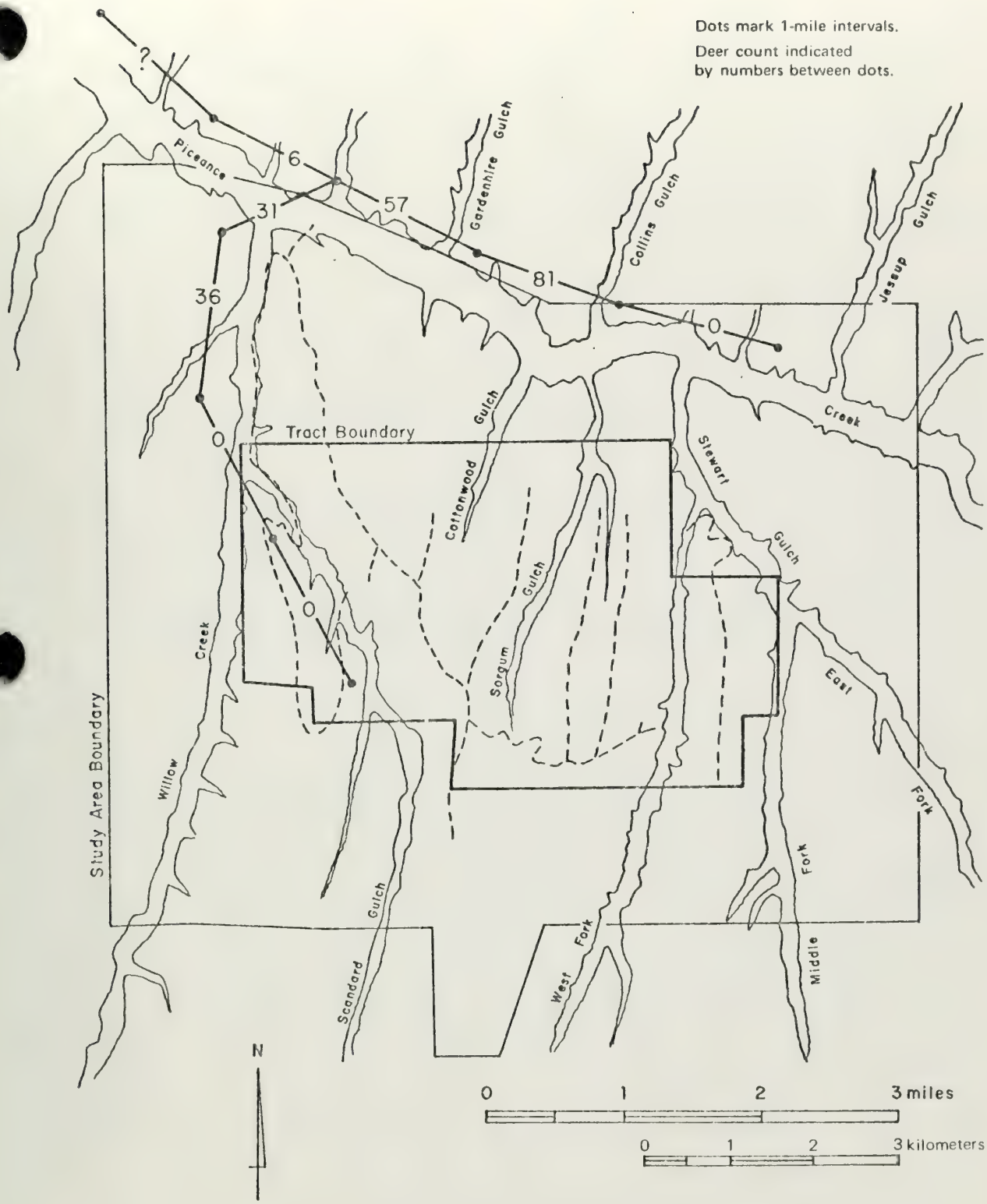


Figure I-4. DEER CONCENTRATIONS, NOVEMBER 19, 1974

conspicuous. The abundance of deer tracks in fresh snow will be recorded along established flight paths using fixed-wing aircraft. The area of study will extend outside the boundaries of Tract C-b, although deer movement and concentrations in the C-b area will be emphasized.* Ground reconnaissance will be necessary to count individual deer, obtain age-class data, and locate bedding grounds, feeding areas, and local travel routes.

Eleven transects have been established on Tract C-b for pellet group counts (Figure I-1). There are 50 circular plots per transect, 0.01 acre in size. Each plot within a transect is permanently staked in 15-meter intervals. The total number of circular plots in each major vegetation type is in proportion to the estimated acreage of that vegetation type.

In October, all existing pellet groups were removed from the plots. In early spring, after the deer leave the tract, a pellet group survey will be conducted to count winter pellet groups. From this information a distribution of deer and their use of the tract will be evaluated. The number of pellet groups per unit area is calculated by

$$P = \frac{1}{NA} \Sigma p \quad \text{(Giles, 1971)}$$

If Σp is the sum of all winter pellet groups in N plots, and A is the area of one plot, then P is the number of pellet groups per unit area.

Eberhardt and Van Etten (1956) have computed deer-days and total deer by assuming: (a) mean defecation rate, (b) time span over which the pellet groups are deposited, and (c) pellet group count representative of the deer population. Dividing the number of pellet groups per unit area by the defecation rate yields deer-days of use per acre. In the current study we assume a defecation rate of 14 pellet groups per day. We also assume that the deer utilize their winter range for 180 days. Therefore, dividing deer-days use by 180 days would give deer per acre.

Causes of deer mortality in the Tract C-b area will be studied monthly during the winter and early spring. Large quadrats (generally 4 hectares--about 10 acres) are located in five of the eight major habitat

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*Assistance with the air reconnaissance methods from R. Bartmann of the Colorado Division of Wildlife is appreciated.

types on Tract C-b (covering a total of 240 hectares--about 600 acres). At monthly intervals the quadrats will be searched on foot and all deer carcasses found will be located on an aerial photograph. Information relating to age and approximate time since death will be noted. Data obtained from this study will indicate what factors limit the area deer population. In the Tract C-b area, the factors probably include hunting, predation, and winter kill (a combination of inclement weather and poor nutrition).

Partial quantification or categorization of deer losses has obvious management application. Deer loss information is fundamental to understanding ecosystem functioning, since deer influence range conditions and sustain large predators. (Methods used to verify predator kills are explained later).

Deer loss information can be used to identify critical habitat types. If high winter deer mortality occurs in certain areas on the tract, it indicates areas sought out by deer during stressful winter conditions. As such, these areas could be critical to winter survival. The relative importance of Tract C-b compared to the surrounding vicinity can be described in terms of differences in deer mortality. Tract C-b can then be evaluated in relation to the rest of the Piceance Basin.

The information gathered from pellet group surveys, together with aerial and road count surveys, and winter mortality counts, will be used to describe the structure and dynamics of the winter deer population on Tract C-b, their differential use of the area, and those factors which may be important in population regulation.

Tract C-b is an important winter range for a portion of the Piceance Basin herd. To evaluate the extent to which deer utilize this area, a shrub utilization study has been devised. The method is a modification of those presented by Aldous (1944) and Patton and Hall (1966), and yields information on the percentage of utilization and condition of each browse

species. In conjunction with the productivity studies by the vegetation team, an estimate of production will be available to compute actual deer utilization for selected browse species.

Shrubs to be monitored in the production-utilization studies include mountain mahogany (Cercocarpus montanus), big sagebrush (Artemisia tridentata), and serviceberry (Amelanchier alnifolia). At selected plots within each pellet group transect, the above shrubs are tagged and measured. Four current-year shoots per species are selected at random and are permanently marked with aluminum tags. The current year's growth on these marked shoots is measured to the nearest millimeter and recorded to provide a measure of mean growth per species. Additionally, five individual shrubs of the above species are selected randomly for shoot clippings. From each selected shrub, 25 shoots with current year's growth are measured and clipped. A mean value for current year's growth is provided from these measurements, as well as a mean biomass value by species. The shoots are then analyzed for nutrient content.

In the spring, the extent of browsing is determined by measuring the length of the remaining shoots on the tagged shrubs. Additionally, a survey is conducted to evaluate the overall condition of all browse species in the pellet group transects.

Big Game-Livestock Competition

The degree of competition between mule deer and livestock on Tract C-b will be determined by the amount of area and number of forage species browsed in common (Julander, 1958). The distribution and density of both species populations are determined by the presence of deer pellet groups and cow droppings, with the number of droppings related to the degree of area utilization. Cow droppings are counted in the same plots already established for counting deer pellet groups.

Forage use is determined by estimating the annual herbage production and percent utilization of key species. The annual herbage production is obtained from vegetation studies on Tract C-b. Two vegetation plots are used to obtain the percent utilization of various plant species. One plot is unfenced and readily available to deer and cattle. The other plot is fenced to prevent cattle from entering but does not exclude deer. Data from clippings in these two plots result in the percent utilization by deer and cattle in the open plot and the percent utilization by deer in the other plot. The difference in these two results is the percent utilization for cattle. The cattle exclosures should not be confused with the 7-foot-high deer and cattle exclosures that differentiate vegetation changes due to oil shale activities from those due to intense grazing and browsing pressures.

Medium-Size Mammals

The medium-size mammals include lagomorphs; larger rodents such as beaver, muskrat, porcupine, and marmot; and smaller predators such as the badger and striped skunk. Bobcats and coyotes are considered large predators.

Abundance of most medium-size mammals is difficult to monitor. Cottontails, jackrabbits, and to a lesser extent raccoons, skunks, and marmots can be meaningfully studied to determine relative abundance and ecosystem relationships. The extent and quality of any rare species are evaluated.

The track count methods previously described (see Big Game) were devised at the outset to monitor medium-size mammals. The methodology works for certain medium-size species and was considered by the field investigators to be superior to other methods.

Large Predators

Most of the major vertebrate predators and prey species in the Tract C-b area have been identified. Methods used included direct

observation, live trapping, vocalizations, track counts, and indirect signs of activity (droppings, dens, remains of kills).

The standardized scent-station technique, developed by the U.S. Fish and Wildlife Service, is used to quantify coyote abundance. A station consists of a 3-foot circle of sifted earth with a capsule containing an attractant placed in the center. The attractant draws coyotes to the prepared station. Fifty stations are located at 0.3-mile intervals covering a distance of 15 miles. All 50 stations are checked for 3 to 5 successive days. The abundance of coyotes is calculated as a visit frequency. Although the method has been most successfully used for coyotes, it is also used to quantify the abundance of other predators (canids, felids, mustelids), which are also attracted to these stations. The tracks of other species not necessarily drawn by the attractant (accidentals) also occur at these stations. Two scent-post surveys were conducted near Tract C-b. One was checked for a 5-day period; the other for 3. Thus, 400 stations were examined, providing considerable opportunity for track occurrences (Figure I-5).

The prey utilized by coyotes during winter will be evaluated by scat analysis, and by examination of deer kills. Coyote scats were not systematically collected the past quarter, because of the difficulty of aging them accurately. Collections along established lines previously cleared of droppings will be made next quarter as part of a coyote food-habit study.

Deer mortality will be categorized by its various causes, and bone marrow analysis will be used to assess the physical condition of dead deer. Predator kills can be distinguished from simple carrion feeding by evidence of hemorrhaging where the bite occurred. The condition of the corpse, drag marks, and tracks permit identification of the predator responsible for the kill. Coyotes, bear, lions, and eagles usually manifest unique kill characteristics. Separating predator kills from deaths by

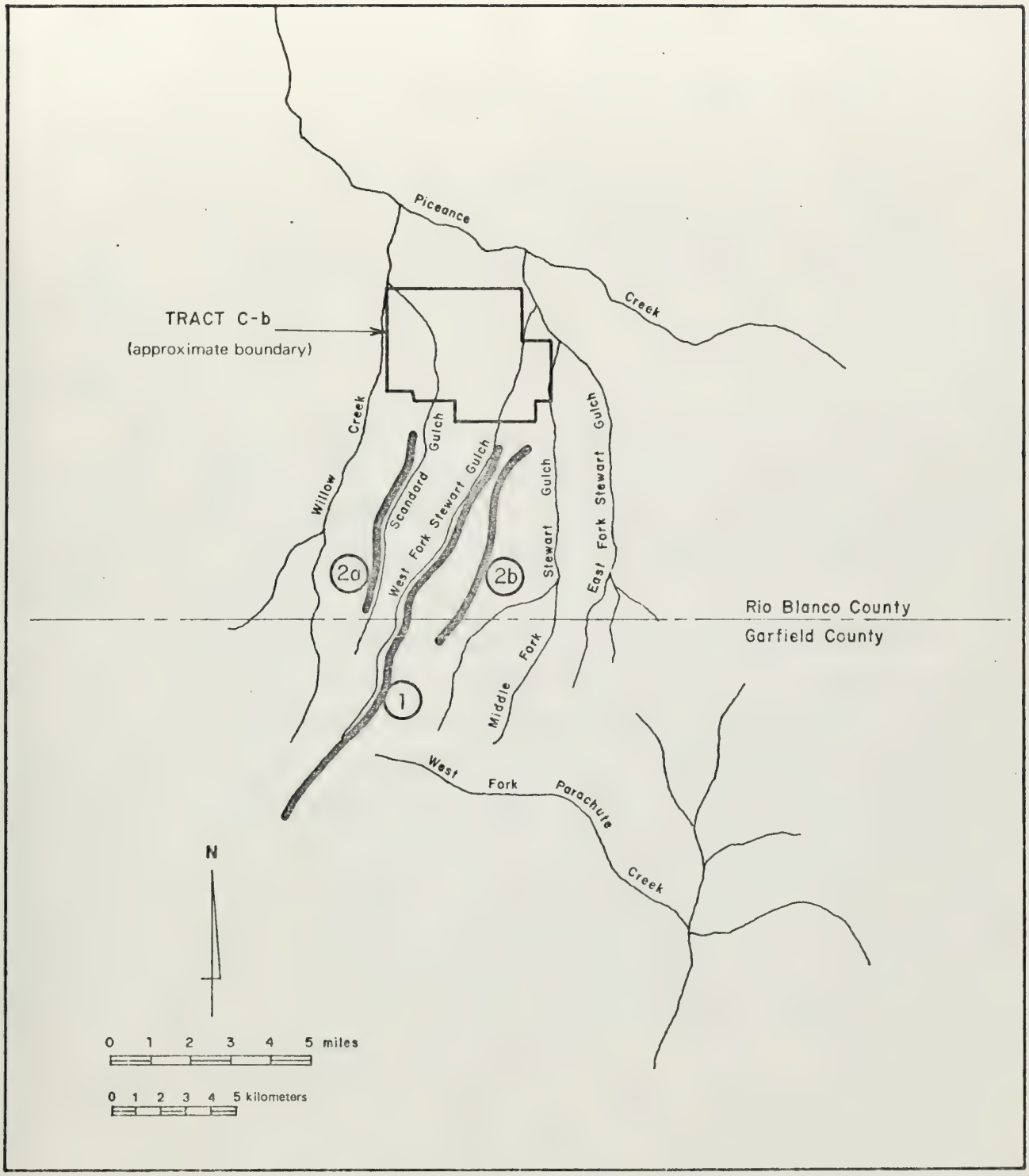


Figure I-5. LOCATIONS OF PREDATOR SCENT-POST SURVEY LINES

starvation during winter is difficult because scavengers (magpies, ravens, and coyotes particularly) have sufficient time to consume a dead animal. For this reason mortality quadrats should be checked at monthly intervals at least.

Investigations of predatory bird food habits include examining nests and owl roosts for prey remains. Bone fragments are collected and identified to provide information on prey preference and prey diversity.

Small Mammals

Small mammals expected in Tract C-b include shrews, squirrels and chipmunks, gophers, rats, mice and voles. Shrews, squirrels, and gophers present problems in quantitative studies and are only indicated in qualitative terms. Mice, voles, and chipmunks are abundant and amenable to quantitative study.

Small mammals are studied using Smith live-traps at two locations. These study plots are shown in Figure I-1. Site 1 is on an undulating plateau (elevation about 7000 ft), overlooking Scandard Gulch and the Little Scandard Gulch drainage to the south. Overstory vegetation consists of infrequent pinyon and juniper saplings. Older and larger pinyon and juniper trees were previously uprooted by chaining operations. Many large woodpiles remain as a result of the earlier chaining. Shrub species include big sagebrush (Artemisia tridentata), bitterbrush (Purshia tridentata), snowberry (Symphoricarpos oreophilus), mountain mahogany (Cercocarpus montanus), and rabbitbrush (Chrysothamnus nauseosus). Crested wheatgrass (Agropyron cristatum) and western wheatgrass (Agropyron smithii) are common in the more open areas between woodpiles. Site 2 is on a western slope and ridgetop (elevation about 7000 ft), overlooking the west fork of Stewart Gulch. Vegetation consists of a pinyon-juniper woodland (Pinus edulis, Juniperus osteosperma, J. scopulorum) and an understory composed mainly of big sagebrush and western wheatgrass.

At each study plot, Smith live-traps are placed at 15-meter intervals on an inner grid. The inner grid is a 10-by-10 trap arrangement totaling 100 traps in an area of 4.6 acres. A perimeter line without traps lies 15 meters outside the grid. This line serves to separate the inner grid from two dense lines designated X and Y. The purpose of the X and Y dense lines is to assess movement into and out of the 10-by-10 grid. It also serves to separate dense line individuals from the 10-by-10 grid individuals. The two dense lines employ 116 traps, which together with the inner grid total 216 traps in an area of 14.7 acres.

Trapped animals are marked by two different methods. Animals too small to be ear-tagged (deer mice, voles, pocket mice, chipmunks) are toe-clipped, while larger animals (rabbits, squirrels, wood rats) are ear-tagged with monel tags. In addition to tagging animals the sex, life history stage, weight, reproductive state, and presence of parasites are recorded. During subsequent captures this information is recorded again.

All of the above information is transferred to computer punch cards and then analyzed on an IBM 360/67 computer. Information from the X and Y dense lines establishes which peripheral individuals actually live within the 10-by-10 grid.

The computer program calculates density estimates using two different indices: (1) Haynes' estimate based on cumulative captures, and (2) EM-2 estimate based on the proportion of marked to unmarked individuals over time. Additional information computed by this program includes probability estimates of mortality, trap avoidance, and emigration. Summarized results consist of population estimates by species, life history stage, and sex, in addition to numbers captured and released by trapping period.

To thoroughly assess the distribution of species on Tract C-b and determine their specific habitat preferences, an array of satellite grids has been established. These grids cover the majority of habitats available

including riparian, meadow, valley sagebrush, plateau sagebrush, rimrock, canyon mouth/sagebrush, canyon/pinyon-juniper, canyon/mountain shrub, and canyon/mountain grassland. The satellite grids are a 4-by-6 array of Smith live-traps placed 15 meters apart. Animals caught in these grids are not permanently marked. The purpose of these smaller grids is to assess relative abundances, habitat preferences, and distribution over Tract C-b. Information regarding life history stage, sex, reproductive state, and presence of parasites is recorded and utilized as in the permanent grid systems.

The nomenclature used for small mammals follows that of Wild Mammals of Colorado by Lechleitner (1969).

Birds

Eight habitat types in and around Tract C-b have been established with Emlen strip transects. They include sagebrush bordered by pinyon-juniper, riparian meadow, sagebrush-rabbitbrush, mature pinyon-juniper, mature pinyon-juniper interspersed with sagebrush and mountain shrub, chained pinyon-juniper, sagebrush-grass, and mountain shrub. Location of the 800-meter routes (ornithological transects) are depicted on Figure I-1. Table I-1 briefly describes each transect.

At each of these plots, Emlen strip censuses (Emlen, 1971) are employed to obtain quantitative estimates of avian density. All eight transects were quantitatively sampled between October 8 and 10, while only the chained and unchained pinyon-juniper sites, W. Oldland riparian site, and the Stewart Gulch sagebrush-rabbitbrush site were sampled during late November.

The field technique employed consists of an observer walking slowly along the chosen transect and recording all individual birds seen and heard, by species, according to their perpendicular distance from the transect route. The observations are grouped in perpendicular distance categories of 0-10, 10-25, 25-50, 50-100, 100-200, and 200-400 feet.

Table I-1. DESCRIPTION OF THE EIGHT EMLEN STRIP TRANSECTS ON TRACT C-b

Transect 1 (Collins Gulch). The Emlen strip transect runs south to north on the west slope of Collins Gulch; this strip is bordered on the west by sandstone banks which maintain a sparse covering of pinyon-juniper and mountain shrub. A north-south highway forms the eastern boundary of the strip (transect bearing 15°).

Transect 2 (Oldland Ranch/Piceance Creek). Bordered by grazed pasture, this transect traverses Piceance Creek west to east. Several small stands of Douglas fir and mountain shrub border the southeastern corner of the plot (transect bearing 120°).

Transect 3 (West Fork of Stewart Gulch). Bordered to the east and west by sharply rising slopes, this north-south transect traverses a dense, heterogeneous stand of sagebrush and rabbitbrush. The eroded sandstone slopes support a sparse growth of pinyon-juniper (transect bearing 12°).

Transect 4 (Mammal Plot No. 2). This transect route through a pinyon-juniper woods includes only one habitat type. The trees are primarily mature pinyon pine and juniper with a sparse understory of mountain shrub (transect bearing 65° for 300 meters, and 340° for 500 meters).

Transect 5 (Middle of Sorghum Gulch). This plot consists of a mature but sparse stand of pinyon-juniper. Big sagebrush, Gambel's oak, and serviceberry comprise the thin understory (transect bearing 3° for 350 meters, 60° for 100 meters, and 165° for 350 meters).

Transect 6 (Mammal Plot No. 1). This transect consists of chained pinyon-juniper. The vegetation includes a heterogeneous mixture of immature pinyon pine, serviceberry, Gambel's oak, sagebrush, and bitterbrush. A large number of snags provide specialized habitats for certain birds (transect bearing 140°).

Transect 7 (Vegetation Plot 3). This Emlen strip traverses through upland sagebrush and grass. The extreme south boundary borders a sparse stand of immature pinyon-juniper (transect bearing 359° for 350 meters, 90° for 125 meters, and 175° for 325 meters).

Transect 8 (Willow Creek). This steep, north-facing slope traverses east to west through a mountain shrub habitat. An overstory of pinyon pine and juniper is scattered throughout the transect, while a dense mixture of serviceberry, Gambel's oak, sagebrush, and snowberry make up the understory (transect bearing 310°).

These distances are later used to calculate differential detectability of various species, depending upon average distance from the observer at the time of sighting. Transects are plotted on USGS 7.5-minute topographic maps, and their length measured and converted to meters.

Population densities are determined by three calculation methods, (A), (B) and (C), according to the formula given in Figure I-6. (A) expresses the total number of individuals of a species recorded in the census in terms of total area sampled. (B) adjusts this estimate using a coefficient of detectability (C.D.), which recognizes that species differ in their conspicuousness to the observer, and therefore have differing probabilities of being recorded with increasing distance from the transect route. The coefficient represents the proportion of a species' population in an area which is ordinarily detected by an observer traversing the transect. (C) further adjusts this estimate to account for underestimations in densities close to the transect route, where calculation (B) assumes complete censusing.

Because the validity of any of these estimating techniques varies for different species, professional judgment is used in selecting the best method to determine density estimates for each species. For species that are either associated with distinctive habitat types or are quite conspicuous but occupy large activity areas, method (A) usually provides the best estimation. For most other species, calculation (B) yields the best approximation of actual densities, especially during winter when conspicuousness diminishes rapidly past some "critical distance" from the transect route. At that point, the species may not be seen until they flush nearly underfoot; for these, densities are undoubtedly underestimated using method (B), and a "basal detectability adjustment" factor of 1.05 is used (C).

Dominant bird species of each vegetation type are identified by values of relative density calculations. The percent of relative density is determined according to the following formula:

Figure I-6. DATA ANALYSIS--STRIP CENSUSES

Species:_____ Dates:_____

Site:_____ Comments:_____

_____

Project:_____

COUNT RESULTS SUMMARIZED

Individuals Observed

Date	0-10'	10-25'	25-50'	50-100'	100-200'	200-400'	Σ
Σ							

Basal Plateau Level:_____ Projected Census:_____ Strip Width:_____

Total length of census strip (km):_____ C.D. = $\frac{\text{Observed}}{\text{Projected}}$ = _____

CENSUS ESTIMATE

(A) Unadjusted: Strip width (_____) x strip length (_____) = _____ km^2

Number observed (_____) ÷ _____ km^2 = _____ individual/km^2

(B) Adjusted for C.D.: $\frac{\Sigma \text{ observed}}{\text{C.D.}}$ / _____ km^2 = _____ individual/km^2

(C) Adjusted for C.D. and Basal Detectability: B.D. Adjustment = _____

Revised census: B.D. x Census Estimate B = _____ individual/km^2

$$\text{Percent Relative Density} = \frac{\text{density of species A}}{\Sigma \text{ density of all species}} \times 100$$

While the Emlen technique quantifies absolute density of species in those specific tract habitats which are sampled, it is too time-consuming for covering extensive areas. To achieve a fuller indication of bird species utilization of the full range of habitats on Tract C-b, qualitative censuses are made within a variety of habitat types. These areas are walked and the species of birds observed in each are recorded.

During the early October and late November census periods, the Walter Oldland ranch pond and the P-L Ranch pond were visited systematically, and the number of individual ducks by species were recorded. Waterfowl utilization in bird-use-days was calculated.

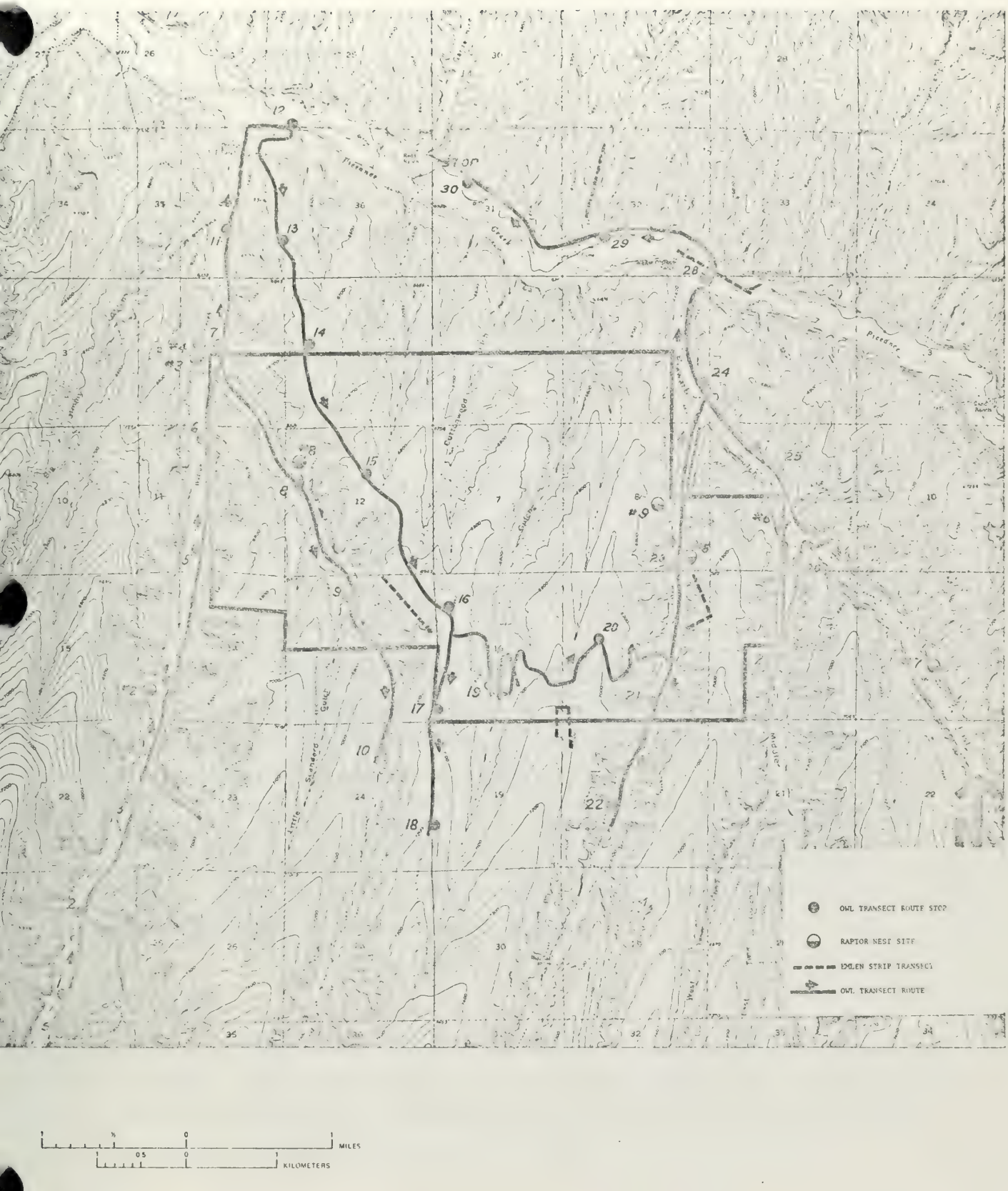
Predatory birds are recorded by species, age class, and location. Relative abundance of the more common species is calculated as:

$$\text{Percent Relative Abundance} = \frac{\text{number of species A}}{\Sigma \text{ number of all species}} \times 100$$

as determined by sightings from Emlen strip transects and qualitative field observations. All vacant nests noted during routine field work are recorded, photographed, and plotted on maps. Pellets and casts are collected and recorded as to location in association with nest sites. These will be analyzed for species content of prey; results will assist in defining predator-prey relationships on Tract C-b.

A night road transect having 30 stops spaced 0.7 mile apart is traversed (Figure I-7), to assess owl activity. Owl counts begin from sundown to two hours after sundown. At each stop, the observer leaves the vehicle, walks a short distance away and records by species the number of owls heard or seen during a 5-minute period. All observations are recorded on a standard data sheet.

Nomenclature used in this report follows the American Ornithologists' Union Checklist of North American Birds (AOU, 1957), as updated by the 32nd supplement to the checklist (AOU, 1973).



igure I-7. OWL TRANSECT ROUTE

Reptiles and Amphibians

Reptiles. Forty-nine pit-can traps on a 7-by-7 grid and spaced 15 meters apart are placed at sites 1 and 2 (Figure I-1). The pit-cans are polypropylene buckets with an inside liner and are buried with the top edge flush with the surface. A 1-foot plywood square covers the open pit-can. Reptiles are captured when they crawl under the plywood cover and fall into the open can while foraging, hunting, or searching for cover.

If numbers of reptiles are sufficiently large, a mark and recapture method for estimating density will be employed based on the modified Petersen Index (Roff, 1973).

$$N = \frac{M\ (n + 1)}{(m + 1)}$$

where M = number of marked reptiles released from sample 1

n = number of reptiles in sample 2

m = number of marked reptiles in sample 2.

Data on species, sex, age, and reproductive condition will be recorded as the reptile is marked.

Noosing, counts per unit effort, and general reconnaissance on Tract C-b and in nearby areas will be employed on a qualitative basis. This information will be utilized to further assess relative abundance and distribution of species by habitat.

Amphibians. The distribution and species composition of amphibians on and around the tract will be evaluated mainly by a reconnaissance of seeps, streams, and ponds. Observations, hand captures, and counts will provide information on relative abundance.

Arthropods

Ground Arthropods. The seasonal distribution and abundance of ground arthropods will be described utilizing data obtained from the pit-cans. Captured arthropods are preserved in 70 percent alcohol and returned to the laboratory for identification.

Other Arthropods. Information on the seasonal distribution and abundance of non-ground insects and other arthropods is gathered by beating the vegetation with a sweep net. Plants are sampled systematically by species. A collector beats three to five plants of the same species within a vegetation type until the majority of conspicuous plant species are sampled. The arthropods are preserved in 70 percent alcohol and later identified to the lowest possible taxonomic division. All arthropods collected in this manner are listed with information concerning associated plant species, trophic level occupied, and relative numbers.

Soil Arthropods and Microarthropods. Soil microarthropods from four major vegetation associations will be surveyed and identified. The survey will quantify by number and, where possible, by functional categories, the soil-formation relationships between soil microarthropods and four vegetation associations: sagebrush, serviceberry, mountain mahogany, and grassland.

Samples from eight sites in the main survey area are taken with a small entrenchment tool. Approximately 12 square inches of soil is removed to a depth of 1.5 to 2 inches and placed in plastic bags. The bags are labeled for identification of the material. Soil temperatures are taken at each location. The bags are transported to the soils laboratory and placed into Berlese funnels for four days. After initial extraction of the main numbers of microarthropods, the samples are allowed to run for two or three more days to determine if additional organisms can be extracted by a prolonged run. Specimens are sorted in calibrated petri dishes and populations estimated by random sampling. Examples of different orders (and families) will be mounted on slides for identification. New species will be described. Records will be kept of the types and numbers found in the samples and the data correlated with the season, the plant type, and other factors that affect changes in the faunal composition. Populations of different acarine groups and their effects will be analyzed after the seasonal collections have been completed. Soil subsamples are also returned to the laboratory for bacterial/fungal culture preparations, identifications, and enumeration.

RESULTS AND DISCUSSION

Big Game

While continuing observation may reveal the presence of elk (Cervus canadensis) or black bear (Ursus americanus) on or near Tract C-b, the only species of big game so far definitely identified there is the Rocky Mountain mule deer (Odocoileus hemionus Rafinesque). During the May 1974 reconnaissance it was thought that elk might be present, but no confirming evidence of their presence has been found to data.

Deer were virtually absent from the Tract C-b area during August of 1974; in September, some tracks were noted and a few deer sighted in the lower valleys and agricultural meadows. In October, a significant influx of deer onto Tract C-b became obvious. Many deer and signs of deer activity (tracks and fresh droppings) were seen. This autumn migration was apparently quite abrupt, although observations were insufficient to accurately measure its day-to-day progress.

On October 20, a night road count was conducted in hopes of getting information on the relative abundance of several wildlife species in four of the eight major habitat types (Table I-2). The data from night road counts have been meager and this method has been abandoned; however, observations along the road through the sagebrush valley of the West Fork of Stewart Gulch showed that large numbers of deer had moved into this area. (On August 23 and September 15, night road counts along this same stretch of road were made without a single deer being spotted.)

Track counts conducted on October 20 were more successfully used to assess relative habitat utilization by medium to large mammalian species (Table I-3). High deer usage of the pinyon-juniper woodland type and lower valleys and agricultural meadows was evident (100 percent of quadrats had tracks), with appreciable activity also apparent in upper sagebrush valleys and mixed mountain shrub types.

Table I-2. NIGHT ROAD COUNTS CONDUCTED NEAR TRACT C-b

Date	Habitat type	Animals observed	Miles	Deer/Mile
Aug 23	pinyon-juniper woodland (near drill site 17)	1 cottontail	4	
	chained pinyon-juniper (West Fork Stewart to Sorghum Gulch)	1 horned owl	4	
	upper sagebrush valley (West Fork Stewart)	1 horned owl	4	
	lower valleys and agricultural meadows (P-L Ranch gate to Stewart Gulch)	none	4	
Sept 15	upper sagebrush valley	none	6.6	
	lower valleys and agricultural meadows	3 deer 1 cottontail	10	0.3
Oct 20	pinyon-juniper woodland	1 horned owl	4.2	
	chained pinyon-juniper	none	4.7	
	upper sagebrush valley	40 deer	6.6	6.1
	lower valleys and agricultural meadows (Rock School to Oldland's ranch)	3 deer	9.1	0.3

Table I-3. PERCENT OF QUADRATS IN WHICH VARIOUS ANIMAL TRACKS WERE OBSERVED, BY HABITAT TYPE, OCTOBER 20, 1974

Habitat Type	deer	coyote	bobcat	cottontail	jackrabbit	raccoon	skunk	marmot	porcupine
pinyon-juniper woodland	100				5				5
chained pinyon-juniper				40					
upper sagebrush valleys	30			30					
mixed mountain shrub	55	50	5	10					
lower valleys and agricultural meadows	100	40				5	5		

Note: Quadrats were placed along 500-meter transects.

Large concentrations of deer were observed in the lower valleys and agricultural meadows during October and November (Figures I-8, I-3, and I-4). On October 19, meadow counts were made along 18 miles of road between Rock School and McCarthy Gulch (Figure I-8). The numbers of deer using separate hay meadows were counted at dusk from a single observation point between Cottonwood and Sorghum gulches. Deer moved into these meadows at an increasing rate toward dusk, and continued to move in after dark. This could be noted in the failing light in the nearest meadows. All deer observed came from the south, in the direction of Tract C-b; none were seen crossing the road from the north, although lesser numbers of deer have been subsequently observed coming from this direction. Most of the deer approached the meadows by traveling down hillsides rather than moving directly out from the tributary valley floors, but many deer do move downslope along the dry creek beds and are thus more inconspicuous because of the denser vegetation.

It was surprising to find deer heavily concentrated in agricultural meadows immediately adjacent to Tract C-b while almost nonexistent along miles of similar-appearing meadows to either side of the Tract C-b area. In November, this same basic distributional pattern was evident (Figures I-3 and I-4). Differences in palatability of forage are unlikely to account for this variation. And while it is conceivable that soil differences could be involved, it is probably not from the previous season's agricultural treatment, since the local rancher claims that deer have concentrated in these same meadows in years past. These distributional patterns, as well as local routes of travel, will be studied further during winter.

Additional counts made by field investigators are listed in Table I-4. These will be discussed in our next quarterly report.

An important adjunct to the deer road-count studies has been information obtained on age-class composition of the herd (Table I-5). This information is especially useful for evaluating spring survival of fawns,

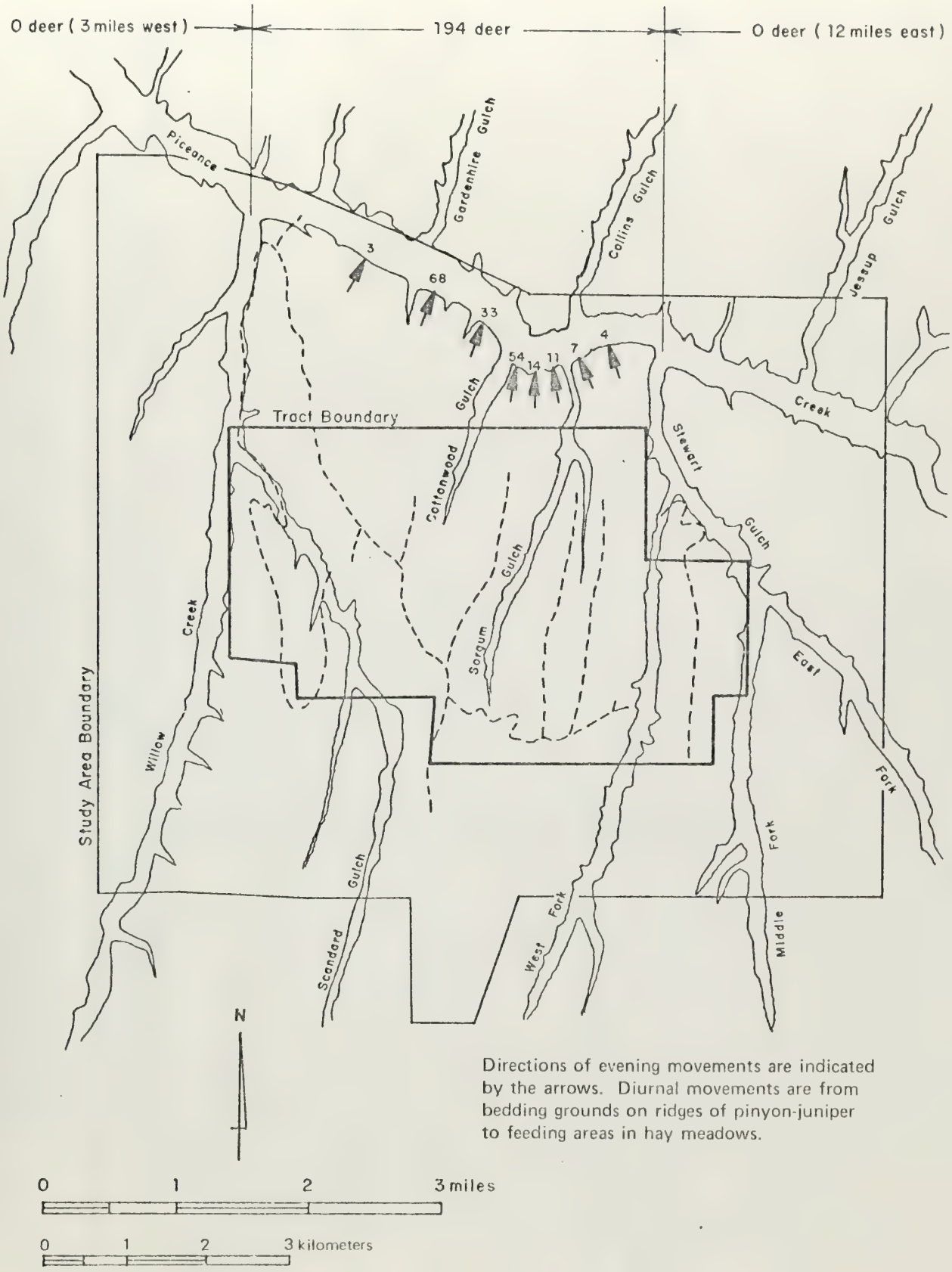


Figure I-8. DEER COUNT ALONG PICEANCE CREEK, OCTOBER 19, 1974

Table I-4. NUMBERS OF GRAZING DEER ALONG WILLOW CREEK AND PICEANCE CREEK DURING OCTOBER AND NOVEMBER, 1974*

		East from Tract C-b Entrance to Rio Blanco					Willow Creek from Scandard Fork to Tract C-b Entrance					North Piceance Creek to Tract C-b Entrance					Total for
Date	(Time)	Mile	Doe	Fawn	Buck	Total	Mile	Doe	Fawn	Buck	Total	Mile	Doe	Fawn	Buck	Total	Day
Oct. 24	(1800)	1-18				112	2										112
Oct. 25	(1800)	1-18				67	2				42						109
Nov. 7	(1500)	1-18				23	2				31						54
Nov. 8	(1700)	1-18				158	2										158
Nov. 8	(--)	1-18				21	2										21
Nov. 12	(--)	1	19	22	4	45	2	24	28	2	54	1				23	270
		2	36	44	12	92						2				32	
		3				16						3					
							1-18					4				8	
Nov. 14	(1645)	1				27						1	3	2	1	6	101
		2				29						3		2		2	
		3				14						7	6	2		8	
												8	8			8	
												9				7	
Nov. 15	(1715)	1				31	1	18	7		25						237
		2				32	2	38	5	2	45						
		3				36	3	22	5		27						
		5				4											
		6				15											
		7				14											
		9				8											
Nov. 19	(1700)	1	40	14	1	55											206
		2	104	12	3	119											
		3	28	4		32											
Nov. 20	(--)	1-18				25	2				54						79
Nov. 21	(--)	1-18				50											50
Nov. 22	(1700)	1	36	14	3	53						1	15	9	2	26	135
		2	36	15	2	53											
		3	2	1		3											
		4															
		5															

*See Figure I-1

predicting the future status of the population, and estimating the magnitude of spring predation on fawns.

Table I-5. AGE-CLASS COMPOSITION OF MULE DEER ALONG PICEANCE CREEK IN THE VICINITY OF TRACT C-b

Date	Fawns	Does	Bucks	Reproductive Success (percent Fawns to Does)
October 21	154	96	-	160
November 12	104	78	9	133
Nobember 19	89	67	12	133

Studies of the winter range shrub-utilization by mule deer have commenced. From 11 transects and 550 plots, 14, 16, and 47 shrubs of serviceberry (Amelanchier alnifolia), mountain mahogany (Cercocarpus montanus), and big sagebrush (Artemisia tridentata), respectively, have been tagged, and four random shoots per shrub measured. The mean shoot length of tagged current year's growth is 51.6 mm (serviceberry), 80.0 mm (mountain mahogany), and 46.5 mm (big sagebrush). The shoot measurements are presented in Table I-6. Information from these tagged shrubs will be used to determine the amount of browse consumed by deer.

Browse species selected to determine nutrient content and dry weight biomass of current year's growth have been clipped and measured. These data are presented in Table I-7. Average shoot lengths for serviceberry, mountain mahogany, and big sagebrush are 164.2 mm, 166.9 mm, and 117.8 mm, respectively.

Big Game-Livestock Competition

Tract C-b is grazed by cattle during much of the year. Grazing of federal land is under the supervision of the Bureau of Land Management (BLM). Over 7000 head of cattle graze the common allotment that includes

Table I-6. SHOOT LENGTH MEASUREMENTS (in millimeters) OF THREE SPECIES USED IN BROWSE-UTILIZATION STUDIES

Plot Location	TRANSECT 1			TRANSECT 2			TRANSECT 3		
	Amelanchier alnifolia	Cercocarpus montanus	Artemisia tridentata	Amelanchier alnifolia	Cercocarpus montanus	Artemisia tridentata	Amelanchier alnifolia	Cercocarpus montanus	Artemisia tridentata
10-1			21			40	215		34
2			7			39	187		29
3			26			55	242		10
4			24			39	47		15
20-1			36			63	53		
2			28			45	58		
3			22			16	9		
4			30			91	21		
30-1			196			8	18		33
2			137			10	25		10
3			164			5	32		19
4			71			6	45		15
40-1	99		37			15			13
2	44		20			34			27
3	45		66			34			21
4	43		56			47			18
50-1	40	39	32			42	35	75	70
2	50	23	17			13	13	49	36
3	64	25	41			9	22	75	17
4	42	29	21			25	12	99	67
Number	8	4	20			20	16	4	16
Mean	53.375	29.000	52.600			31.800	64.625	74.500	27.125
Range	40 - 99	23 - 39	7 - 196			5 - 91	9 - 242	49 - 99	10 - 70
Standard Deviation	19.9279	7.118	52.158			22.458	76.533	20.420	18.187
95% Confidence Interval	53.38 ± 9.41	29.00 ± 6.74	52.60 ± 27.99			31.8 ± 10.51	64.63 ± 40.77	74.50 ± 32.49	27.13 ± 9.69

Table I-6. (Continued)

Plot Location	TRANSECT 4			TRANSECT 5			TRANSECT 6		
	Amelanchier alnifolia	Cercocarpus montanus	Artemisia tridentata	Amelanchier alnifolia	Cercocarpus montanus	Artemisia tridentata	Amelanchier alnifolia	Cercocarpus montanus	Artemisia tridentata
10-1			82			37			57
2			40			60			54
3			115			31			54
4			129			36			66
20-1			85			50			32
2			54			74			17
3			21			46			26
4			36			28			15
30-1			57			17			76
2			51			16			61
3			37			29			60
4			47			26			53
40-1	11		31			51			43
2	14		10			96			52
3	21		5			28			52
4	37		10			52			56
50-1			14			35			
2			14			21			
3			26			26			
4			7			65			
Number	4		20			20			16
Mean	20.750		51.178			41.200			48.375
Range	11 - 37		5 - 129			16 - 96			17 - 76
Standard Deviation	11.615		37.775			20.631			17.335
95% Confidence Interval	20.75 ± 18.48		51.18 ± 17.68			41.20 ± 9.66			48.38 ± 9.24

Table I-6. (Continued)

Plot Location	TRANSECT 7			TRANSECT 8			TRANSECT 9		
	Amelanchier alnifolia	Cercocarpus montanus	Artemisia tridentata	Amelanchier alnifolia	Cercocarpus montanus	Artemisia tridentata	Amelanchier alnifolia	Cercocarpus montanus	Artemisia tridentata
10-1			54			75			224
2			118			17			150
3			118			77			163
4			76			48			72
20-1			35	36	115	82		42	74
2			17	27	61	40		115	69
3			43	33	93	80		80	115
4			50	42	137	76		93	120
30-1			41		95	20	54	168	
2			30		7	30	49	50	
3			10		155	12	95	49	
4			48		11	30	32	210	
40-1			20	194	23	47		22	
2			49	120	74	11		44	
3			41	61	64	22		43	
4			57	79	210	22		54	
50-1			36	46	157	62	30	67	37
2			47	70	131	66	48	78	28
3			16	28	64	110	13	55	18
4			35	17	54	70	21	114	25
Number			20	12	16	20	8	16	12
Mean			47.050	62.750	90.687	49.850	42.750	80.250	91.250
Range			10 - 118	17 - 194	7 - 210	11 - 110	13 - 95	22 - 210	18 - 224
Standard Deviation			28.865	50.194	57.166	28.826	25.521	50.332	64.296
95% Confidence Interval			47.05 ± 13.51	62.75 ± 31.89	90.69 ± 30.46	49.85 ± 13.49	42.75 ± 17.23	80.25 ± 26.82	91.25 ± 50.40

Table I-6. (Continued)

Plot Location	TRANSECT 10			TRANSECT 11		
	Amelanchier alnifolia	Cercocarpus montanus	Artemisia tridentata	Amelanchier alnifolia	Cercocarpus montanus	Artemisia tridentata
10-1		25	8	18		
2		85	37	30		
3		65	33	55		
4		103	14	32		
20-1			60		81	17
2			24		86	5
3			36		21	30
4			46		68	21
30-1			63	23	37	22
2			40	30	40	118
3			178	41	54	71
4			90	20	10	30
40-1		51	22		26	
2		147	52		159	
3		71	68		121	
4		175	30		295	
50-1					113	
2					80	
3					22	
4					35	
Number		8	16	8	16	8
Mean		90.250	50.062	31.125	78.000	39.250
Range		25 - 175	9 - 178	18 - 55	10 - 295	5 - 118
Standard Deviation		49.856	40.225	12.147	71.257	37.185
95% Confidence Interval		90.250 ± 41.69	50.06 ± 21.43	31.13 ± 10.16	78.00 ± 37.96	39.25 ± 31.09

Table I-6. (Concluded)

	TOTALS OF ALL TRANSECTS BY SPECIES		
	Amelanchier alnifolia	Cercocarpus montanus	Artemisia tridentata
Number	56	64	188
Mean	51.571	79.984	46.484
Range	11 - 295	7 - 295	5 - 224
Standard Deviation	49.794	55.669	36.599
95% Confidence Interval	51.571 ± 13.04	79.984 ± 24.32	46.484 ± 5.23

Table I-7. MEAN ($\bar{x}$, in millimeters), STANDARD DEVIATION (S.D.), AND 95% CONFIDENCE INTERVAL (C.I.), OF NEW YEAR'S GROWTH OF THREE PLANT SPECIES ON TRACT C-b

Plant		Cercocarpus montanus	Amelanchier alnifolia	Artemisia tridentata
1	$\bar{x}$	114.6	236.0	105.4
	S.D.	42.4	94.2	26.8
	C.I.	114.6 ± 17.5	236.0 ± 38.9	105.4 ± 11.1
2	$\bar{x}$	189.4	162.7	134.8
	S.D.	73.6	68.9	47.4
	C.I.	189.4 ± 30.4	162.7 ± 28.4	134.8 ± 19.5
3	$\bar{x}$	178.0	94.5	180.9
	S.D.	75.1	43.6	79.3
	C.I.	178.0 ± 31.0	94.5 ± 18.0	180.9 ± 32.8
4	$\bar{x}$	182.7	143.7	56.1
	S.D.	66.5	68.6	13.8
	C.I.	182.7 ± 27.5	143.7 ± 28.3	56.1 ± 5.7
5	$\bar{x}$	177.6	184.0	111.9
	S.D.	63.9	91.8	41.6
	C.I.	177.6 ± 26.4	184.0 ± 37.9	111.9 ± 17.2
Total	$\bar{x}$	166.9	164.2	117.8
	S.D.	69.8	87.9	61.9
	C.I.	166.9 ± 12.2	164.2 ± 15.4	117.8 ± 10.8

Tract C-b; 650 animal-unit-months (AUMs) of feed are produced on the tract (U.S. Department of the Interior, 1972). Since Tract C-b is also an important winter deer range, direct and indirect competition exists between the deer and cattle populations for the available forage. Direct competition is expected to occur when cattle and deer are present on the tract at the same time. Indirect competition occurs when one group leaves the area after having depleted available forage. Deer are known to occupy the Tract C-b area from approximately September to April; cattle generally utilize the area from April 15 to October 30. Direct competition may therefore exist during the fall and spring when both cattle and deer are present on or near the tract. Indirect competition occurs during the summer when only cattle are grazing the tract and during the winter when only deer are present.

Competition between cattle and deer on Tract C-b is not expected to be critical, however. For one thing, the simultaneous presence of deer and cattle is limited to a few weeks in spring and in fall. Direct competition would be minimal if cattle were removed from the allotment when deer are most abundant on the tract (November 1 to April 15). Direct competition would be increased, however, if grazing periods were to be extended by agreement between the BLM and the five separate ranch operations that graze cattle on the allotment. Indirect competition is expected to be minimal for most of the year since cattle and deer have different forage preferences. Cattle generally graze grass when sufficiently available, while deer apparently prefer forbs and browse such as bitterbrush and mountain mahogany. Julander (1958) found that cattle will utilize bitterbrush when grass supplies are depleted and that deer will eat considerable grass in the spring. This emphasizes the need to remove cattle from the winter deer range in the fall after they have depleted the grass forage and before they begin to utilize any shrubs preferred as deer browse. Effective management of cattle and deer populations by the BLM and the Colorado Division of

Wildlife seems to be the key factor in minimizing competition stresses between deer and cattle populations on and near Tract C-b.

In early spring, cattle exclosures will be erected alongside the vegetation plots, and the vegetation within the cattle exclosures will be monitored to observe responses to cattle exclusion. The vegetation in the cattle exclosures and open areas can be compared to determine the effects of grazing/browsing, and thereby identify the degree of competition between deer and cattle.

Medium-Size Mammals

Cottontail rabbits (Sylvilagus sp.) are an important prey base for some of the larger predators in the area, although they are probably less numerous now than in previous years. The chained pinyon-juniper and upper sagebrush valleys appear to be the best cottontail rabbit habitat. But, while cottontail rabbits were seen here quite often, track count data suggest that the pinyon-juniper woodlands are now little used by them.

Signs of jack rabbits (droppings and tracks) were seen more in the mixed mountain shrub type at higher elevations (south of Tract C-b) than on the tract and immediate vicinity. Only a few individuals have actually been observed, and those were in the lower valleys and agricultural meadows along Piceance Creek and were identified as white-tailed jack rabbits (Lepus townsendii).

Raccoon (Procyon lotor) tracks were common in the mud in most riparian areas, particularly along Piceance Creek. These animals will stray far from this preferred habitat, however, and move not only along drainages but onto slopes and ridges as well. Tracks were occasionally seen in these areas.

Striped skunks (Mephitis mephitis) were seen on two occasions along roads near Piceance Creek. They do not seem to be numerous in the Tract C-b area.

Yellow-bellied marmots (Marmota flaviventris) were commonly seen in August in certain meadows near Piceance Creek, but few have been observed on Tract C-b. They are, in general, not very active by September and tend to go into hibernation early. Their population status will be better understood after next summer's work.

The American badger (Taxidea taxus), muskrat (Ondatra zibethicus), and porcupine (Erethizon dorsatum) inhabit Tract C-b. Signs of all three species are readily recognized, although each has very different habits and requires different methods of study. Their distribution and relative abundance in their respective habitats is not known at present.

Predator-Prey Relationships

The major vertebrate predators and prey species (excluding insectivorous birds) that occur in the Tract C-b area are listed below. Rare and uncommon species are not included, since their role in the ecosystem is not well understood at present.

Major Predators		Major Prey
Birds	Mammals	
red-tailed hawk	coyote	cottontail rabbits (species?)
sparrow hawk	bobcat	chipmunks (species?)
marsh hawk		montane vole
Swainson's hawk		bushy-tailed woodrat
great horned owl		mule deer

Coyote Scent-Post Surveys. Two surveys for coyotes (Canis latrans) were conducted (Figure I-5), one beginning in the West Fork of Stewart Gulch, and the other in Scandard Gulch and on the ridge south of drill site 17. The second line was divided into two 7-mile lengths (2a and 2b). Results are shown below.

Line No.	Species visiting station	Number of visits
1 Stewart (5 days)	coyotes	46
	bobcats	2
	"accidentals"	
	-sage grouse	1
	-jackrabbits	2
	-cottontails	1

Index of coyote abundance = 46 visits/244 operable stations x 1000 = 188.

Line No.	Species visiting station	Number of visits
2a Scandard (3 days)	coyotes	5
	"accidentals"	
	-cottontails	4
2b	coyotes	1
	"accidentals"	
	-jackrabbits	4
	-cottontails	13

Index of coyote abundance = 6 visits/148 operable stations x 1000 = 40.

A coyote abundance index of 188 indicates high density; an index of 40 is fairly low. These also suggest appreciable differences in local distributions. Dividing a 15-mile line into two separate lines is not recommended by the U.S. Fish and Wildlife Service and data obtained from lines 2a and 2b will not be used in subsequent comparisons with Colorado and nationwide surveys. This line will be used, however, for the annual survey to be conducted near Tract C-b, since it is very useful in clarifying local distributions of coyotes as well as other predators and "accidentals."

Raptors. Prey species found at raptor nests included a preponderance of cottontail rabbits. Cottontail rabbits cannot be identified to species using mandibles and cranial fragments. Two species may occur

in the area, but at present only the desert cottontail has been identified. Chipmunk remains tend also to be ambiguous; three species may occur in the area.

Prey species identified at raptor nests included the cottontail rabbit (Sylvilagus sp.), chipmunk (Eutamius sp.), bushy-tailed woodrat (Neotoma cinerea), montane vole (Microtus montanus), deer mouse (Peromyscus maniculatus), common raven (Corvus corax), muskrat (Ondatra zibethicus) and immature bobcat (Lynx rufus). Cottontail rabbits, woodrats, and voles were most commonly represented.

One owl roost was carefully examined. All intact and broken casts were collected at the time, since cattle were trampling the area below the roost. The casts contained mainly mammalian remains (11 voles, 1 deer mouse), but some insects (beetles and grasshoppers), as well.

Small Mammals

Species trapped at both permanent and satellite grids are listed in Tables I-8 through I-13. In the case of satellite grids, habitat type is noted for each sample plot. Sampling dates will be included in the next quarterly report.

Population dynamics and habitat preferences will be discussed separately for each species trapped in the permanent and satellite plots.

Least Chipmunk and Colorado Chipmunk. Laboratory identification of the Colorado chipmunk (Entamius quadrivittatus) is tentative at this time. The lack of a male baculum precludes positive identification.

In the first trapping months, therefore, these two species were simply referred to as Eutamius spp. Comments on their population dynamics and habitat preference will be general, with more specific observations and delineation between species to follow in subsequent reports. Density estimates are provided in Tables I-14 and I-15.

Table I-8. SMALL MAMMAL TRAP DATA FOR SITE 1, CHAINED PINYON-JUNIPER, TRACT C-b (August 1974)

SPECIES		PERMANENT				GRIDS			
		1080 Traps		500 Traps		580 Traps		5 Trap Nights	
Scientific Name	Common Name	Total Capt.	% of Traps Set	Grid Capt.	% of Traps	Dense Capt.	% of Traps	Density Hayne	Em-2
Spermophilus lateralis	golden-mantled ground squirrel	3	0.28	0	0	3	0.52		
Eutamias spp.	chipmunks	187	17.32	42	8.40	145	25.00	19.5	12.3
Microtus spp.	voles	47	4.35	18	3.60	29	5.00	0.0	6.0
Neotoma cinerea	bushy-tailed woodrat	8	0.74	2	0.40	6	1.04		
Perognathus apache	Apache pocket mouse	4	0.37	0	0	4	0.69		
Peromyscus maniculatus	deer mouse	204	18.89	74	14.80	130	22.41	23.9	18.9
Sylvilagus audubonii	desert cottontail	1	0.09	0	0	1	0.17		
Mustela erminea	ermine	1	0.09	0	0	1	0.17		
*Lagurus curtatus	Sagebrush vole	1	0.09	0	0				
	TOTAL	455	42.13	136	27.20	319	55.00		

*Since preparation of this report, this species has been identified.

Table I-9. SMALL MAMMAL TRAP DATA FOR SITE 1, CHAINED PINYON-JUNIPER, TRACT C-b (September 1974)

SPECIES		PERMANENT GRIDS							
		1080 Traps		500 Traps		580 Traps		5 Trap Nights	
Scientific Name	Common Name	Total Capt.	% of Traps Set	Grid Capt.	% of Traps	Dense Capt.	% of Traps	Density Hayne	Em-2
Eutamias minimus	least chipmunk	208	19.26	64	12.80	144	24.83	24.4	25.6
Eutamias quadrivittatus (?)	Colorado chipmunk	5	0.46	2	0.40	3	0.52	1.0	1.0
Microtus montanus	montane vole	31	2.87	12	2.40	19	3.27	21.4	1.2
Neotoma cinerea	bushy-tailed woodrat	11	1.02	6	1.20	5	0.86	4.0	1.2
Peromyscus maniculatus	deer mouse	300	27.78	109	21.80	191	32.93	68.8	51.9
	TOTAL	555	51.39	193	38.60	362	62.41		

Table I-10. SMALL MAMMAL TRAP DATA FOR SITE 2, PINYON-JUNIPER, TRACT C-b (August 1974)

SPECIES		PERMANENT				GRIDS			
		1080 Traps		500 Traps		580 Traps		5 Trap Nights	
Scientific Name	Common Name	Total Capt.	% of Traps Set	Grid Capt.	% of Traps	Dense Capt.	% of Traps	Density Hayne	EM-2
Spermophilus lateralis	golden-mantled ground squirrel	3	0.28	1	0.20	2	0.34		
Eutamias minimus	least chipmunk	47	4.35	15	3.00	32	5.52	17.3	3.7
Neotoma cinerea	bushy-tailed woodrat	9	0.83	2	0.40	7	1.21		
Perognathus apache	Apache pocket mouse	3	0.28	0	0	3	0.52		
Peromyscus maniculatus	deer mouse	257	23.80	81	16.20	176	30.34	42.5	32.8
	TOTAL	319	29.54	99	19.80	220	37.93		

Table I-11. SMALL MAMMAL TRAP DATA FOR SITE 2, PINYON-JUNIPER, TRACT C-b (September 1974)

SPECIES		PERMANENT GRIDS							
		1080 Traps		500 Traps		580 Traps		5 Trap Nights	
Scientific Name	Common Name	Total Capt.	% of Traps Set	Grid Capt.	% of Traps	Dense Capt.	% of Traps	Density Hayne	EM-2
Spermophilus lateralis	golden-mantled ground squirrel	6	0.55	1	0.20	5	0.86		
Eutamias minimus	least chipmunk	134	12.41	52	10.40	82	14.14	28.0	14.1
Neotoma cinerea	bushy-tailed wood rat	1	0.09	0	0	1	0.17		
Peromyscus maniculatus	deer mouse	350	32.41	141	28.20	209	36.03	64.4	77.1
	TOTAL	491	45.46	194	38.80	297	51.20		

Table I-12. SMALL MAMMALS TRAP DATA FOR SATELLITE GRIDS, TRACT C-b (September 18-22, 1974)

SPECIES		SATELLITES													
		#1* 15 Traps 1 Trap Night		#2* 25 Traps 1 Trap Night		#3* 25 Traps 1 Trap Night		#4* 25 Traps 1 Trap Night		#5* 25 Traps 1 Trap Night		#6* 25 Traps 1 Trap Night		#7* 25 Traps 1 Trap Night	
Scientific Name	Common Name	Total Capt.	% of Total	Total Capt.	% of Total	Total Capt.	% of Total	Total Capt.	% of Total	Total Capt.	% of Total	Total Capt.	% of Total	Total Capt.	% of Total
INSECTIVORA															
Sorex spp.	shrew														
CARNIVORA															
Mustela erminea	ermine														
RODENTIA															
Spermophilus lateralis	golden-mantled ground squirrel														
Eutamias minimus	least chipmunk			2	8.0	6	24.0	5	20.0	2	8.0	4	16.0		
Eutamias quadrivittatus (?)	Colorado chipmunk							1	4.0						
Microtus spp.	vole	1	6.6									4	16.0		
Neotoma cinerea	bushy-tailed woodrat														
Perognathus apache	Apache pocket mouse														
Peromyscus maniculatus	deer mouse	4	26.6	15	60.0	8	32.0	11	44.0	8	32.0	7	28.0	8	32.0
LAGOMORPHA															
Sylvilagus audubonii	desert cottontail														
TOTALS		5	33.3	17	68.0	14	56.0	17	68.0	10	40.0	15	60.0	8	32.0

*See footnote of Table I-13.

Table I-13. SMALL MAMMALS TRAP DATA FOR SATELLITE GRIDS, TRACT C-b (November 9-22, 1974)

SPECIES		SATELLITES													
		#1* 25 Traps 1 Trap Night		#2* 25 Traps 1 Trap Night		#3* 23 Traps 1 Trap Night		#4* 20 Traps 1 Trap Night		#5* 20 Traps 1 Trap Night		#6* 15 Traps 1 Trap Night		#7* 25 Traps 1 Trap Night	
Scientific Name	Common Name	Total Capt.	% of Total	Total Capt.	% of Total	Total Capt.	% of Total	Total Capt.	% of Total	Total Capt.	% of Total	Total Capt.	% of Total	Total Capt.	% of Total
INSECTIVORA															
Sorex spp.	shrew					1	4								
RODENTIA															
Peromyscus maniculatus	deer mouse	6	24	9	35	4	16	13	65	3	15	2	13		
Microtus spp.	vole					1	4	2	1						
TOTAL		6	24	9	35	6	24	15	66	3	15	2	13		

*Location — Habitat Type

(1) Piceance Creek — Riparian/Willow-Alfalfa
(2) West Fork Stewart Creek — Valley Sagebrush/Rabbitbrush
(3) Collins Gulch — Rimrock/Juniper
(4) Lower Sorghum Gulch — Canyon Mouth/Sagebrush-Rabbitbrush
(5) Middle Sorghum Gulch — Canyon/Pinyon-Juniper-Mountain Shrub
(6) Upper Sorghum Gulch — Canyon/Grass-Mountain Shrub
(7) Lower Cottonwood Gulch — Canyon Mouth/Sagebrush-Rabbitbrush

Table I-14. DENSITY ESTIMATES AT SITE 1, CHAINED PINYON-JUNIPER, TRACT C-b

	EUTAMIAS spp.				PEROMYSCUS MANICULATUS			
	August 1974		September 1974		August 1974		September 1974	
	Hayne	EM-2	Hayne	EM-2	Hayne	EM-2	Hayne	EM-2
Total Individuals	18.1/19.5	12.1/12.3	24.2/24.4	20.4/25.6	22.3/23.9	18.4/18.9	60.0/68.8	43.4/51.9
Adults	18.1/19.5	12.1/12.3	19.7/18.3	16.2/20.4	21.7/23.1	17.5/17.9	39.1/38.1	27.1/34.6
Subadults	0/0.0	0/0.0	3.0/6.0	1.4/2.7	1.0/1.0	1.0/1.0	17.0/29.2	14.1/11.8
Juveniles	0/0.0	0/0.0	0/0.0	0/0.0	0/0.0	0/0.0	0/0.0	0/0.0
Adult Males	8.6/9.2	4.7/8.4	5.6/7.5	3.4/5.3	11.6/13.6	8.7/7.1	17.2/17.2	15.1/18.8
Subadult Males	0/0.0	0/0.0	#1/0.0	0/0.0	0/0.0	0/0.0	5.8/8.6	6.9/8.7
Juvenile Males	0/0.0	0/0.0	0/0.0	0/0.0	0/0.0	0/0.0	0/0.0	0/0.0
Adult Females	9.1/9.8	4.7/4.2	11.2/10.4	10.8/14.3	10.4/10.3	9.2/11.1	24.4/24.0	12.9/16.7
Subadult Females	0/0.0	0/0.0	2.0/4.0	1.3/2.5	1.0/1.0	1.0/1.0	9.6/17.1	6.3/3.6
Juvenile Females	0/0.0	0/0.0	0/0.0	0/0.0	0/0.0	0/0.0	0/0.0	0/0.0

Notes: Entries are in the form *mean density per trap grid/density per trap grid for day 4*

= number of animals marked and released.

Density values in text are given as number of animals/acre; density values in table are number of animals/grid.

Table I-14 (Concluded)

	MICROTUS spp.				NEOTOMA CINEREA		EUTAMIAS spp.	
	August 1974		September 1974		September 1974		September 1974	
	Hayne	EM-2	Hayne	EM-2	Hayne	EM-2	Hayne	EM-2
Total Individuals	1.7/0.0	1.5/6.0	13.0/21.4	.6/1.2 (#10)	3.6/4.0	.9/1.2	.5/#1	.5/1.0
Adults	1.7/0.0	1.5/6.0	10.5/17.0	.6/1.2 (#9)	3.6/4.0	.9/1.2	.5/1.0	.5/1.0
Subadults	0/0.0	0/0.0	#1/0.0	0/0.0	0/0.0	0/0.0	0/0.0	0/0.0
Juveniles	0/0.0	0/0.0	0/0.0	0/0.0	0/0.0	0/0.0	0/0.0	0/0.0
Adult Males	1.0/#4	1.0/4.0	#4/0.0	0/0.0	.8/1.0	.5/0.0	0/0.0	0/0.0
Subadult Males	0/0.0	0/0.0	0/0.0	0/0.0	0/0.0	0/0.0	0/0.0	0/0.0
Juvenile Males	0/0.0	0/0.0	0/0.0	0/0.0	0/0.0	0/0.0	0/0.0	0/0.0
Adult Females	#1/0.0	0/0.0	2.4/4.8	.1/0.0	#3/0.0	0/0.0	.5/1.0	.5/1.0
Subadult Females	0/0.0	0/0.0	#1/0.0	0/0.0	0/0.0	0/0.0	0/0.0	0/0.0
Juvenile Females	0/0.0	0/0.0	0/0.0	0/0.0	0/0.0	0/0.0	0/0.0	0/0.0

Table I-15. DENSITY ESTIMATES AT SITE 2, PINYON-JUNIPER, TRACT C-b

	EUTAMIAS spp.				PEROMYSCUS MANICULATUS			
	August 1974		September 1974		August 1974		September 1974	
	Hayne	EM-2	Hayne	EM-2	Hayne	EM-2	Hayne	EM-2
Total Individuals	14.8/17.3	1.9/3.7	23.7/28.0	16.1/14.1	36.4/42.5	30.4/32.8	63.8/64.4	50.9/77.1
Adults	14.8/17.3	1.9/3.7	16.9/21.6	12.6/12.6	32.7/38.0	28.4/32.7	52.2/54.3	42.7/60.2
Subadults	0/0.0	0/0.0	4.1/5.1	2.0/1.6	3.5/4.0	.9/#3	11.9/9.6	6.9/12.8
Juveniles	0/0.0	0/0.0	0/0.0	0/0.0	0/0.0	0/0.0	0/0.0	0/0.0
Adult Males	#6/0.0	0/0.0	11.1/13.7	4.9/3.4	14.3/15.3	11.3/20.1	24.9/25.3	17.6/22.5
Subadult Males	0/0.0	0/0.0	1.5/2.0	1.0/0.0	1.8/2.0	.8/#2	5.3/3.0	1.5/0.0
Juvenile Males	0/0.0	0/0.0	0/0.0	0/0.0	0/0.0	0/0.0	0/0.0	0/0.0
Adult Females	2.6/3.7	1.3/2.5	6.3/7.4	6.3/7.3	18.9/22.5	19.6/19.1	30.1/31.3	26.2/37.7
Subadult Females	0/0.0	0/0.0	1.2/2.5	.5/1.0	#1/0.0	0/0.0	6.5/5.3	5.0/11.3
Juvenile Females	0/0.0	0/0.0	0/0.0	0/0.0	0/0.0	0/0.0	0/0.0	0/0.0

Notes: Entries are in the form *mean density per trap grid/density per trap grid for day 4*

= number of animals marked and released.

Density values in text are given as number of animals/acre; density values in table are number of animals/grid.

Population estimates for Eutamius spp. were 2.1 animals per acre at site 2 and 2.8 animals per acre at site 1, for the month of August. In September, population estimates were slightly higher with 3.5 animals per acre on site 2 and 3.7 animals per acre at site 1. These estimates combine numbers for both the least chipmunk (Eutamius minimus) and Colorado chipmunk but in future months the estimates will be done separately for each species. Subjective observations suggest the least chipmunk greatly outnumbers the Colorado chipmunk where they occur together.

The higher densities of the least chipmunk and Colorado chipmunk present in September on both permanent grids is best accounted for by the number of subadult animals appearing in that month (Tables I-14 and I-15). On site 2, 4.1 subadults per grid are shown and on site 1 an average of 4.5 new subadults are shown. The increasing number of subadult animals trapped in September is probably due to a large number of young animals born in early summer and now dispersing and gathering fall food supplies. Juveniles were absent from the traps in both August and September indicating that most females had their litters early in the summer before trapping was initiated. Further observations may indicate whether a second litter commonly occurs in this geographic area. However, the literature is doubtful about this possibility (Lechleitner, 1969).

Generally an even ratio of male to female animals appeared in the trappable population. Further trapping will be helpful in establishing definite patterns in sex ratio.

No evidence of reproductive activity was noted in our trapped animals for the months of August and September. Since the animals probably have but one litter in early summer, this would be expected.

Weights were taken on some animals to give estimates of average weight at this time of year. Table I-16 lists these values. Again, these values represent a mixture of weights for the two species. However, with positive field identification now possible, weights of

Table I-16. WEIGHTS (in grams) OF CHIPMUNKS (Eutamius spp.) AND DEER MICE (Peromyscus maniculatus)

	Eutamius spp.		Peromyscus maniculatus	
	Male	Female	Male	Female
Number weighed	15	7	27	17
Range	30 - 70	32 - 50	10 - 50	10 - 50
Mean	47.5	37.7	25.6	21.1
Standard Deviation	9.5	5.9	9.0	8.8
95% Confidence Interval	47.5 ± 5.3	37.7 ± 5.7	25.6 ± 7.2	21.1 ± 45

previously marked individuals will be properly assigned to species in future surveys.

Habitat preference does not seem to be restricted for these species. As shown in Table I-13, the species were trapped in a wide variety of habitat types ranging from valley sagebrush through pinyon-juniper and rimrock. At this time it is premature to speculate on specific habitat preferences by species, however subjective observations suggest that the Colorado chipmunk prefers the wooded areas to the open-chained areas.

Deer Mouse. Population estimates for the deer mouse (Peromyscus maniculatus) population were 4.7 animals per acre in August and 9.3 animals per acre in September on site 2. On site 1 the estimate was 2.7 animals per acre in August and 7.4 in September. A comparison of deer mouse densities in future months will reveal if the higher densities of deer mice on site 2, compared to site 1, are indeed a pattern that will be permanent.

The trappable deer mouse population increased from August to September (Tables I-14 and I-15). This increase may be related to a larger subadult age class present in September. Deer mice reach puberty in approximately one month (Lechleitner, 1969). It is therefore probable that juveniles still not dispersed from their burrows in August were trapped in September as subadults.

Few reproductive animals were noted in either August or September. It appears that the last litter before the cooler months set in was the subadult age-class trapped in September. According to Lechleitner (1969), the next litter could occur as early as April. The sex ratio was approximately 1.0 for all the deer mice trapped on Tract C-b.

Weights for a small sample of deer mice are presented in Table I-16. Average adult weights were 25.6 grams for males and 21.1 grams for females. Weight data will be taken on a seasonal basis beginning in the spring to document weight changes by sex and by life history stage throughout the year.

Robust botflies (Cuterebridae) were found to be parasitizing deer mice on site 2. The larvae of most species in this family are common parasites on rodents. A much lower incidence of infestation was recorded in deer mice at site 1.

Habitat preference for this species is probably the least restrictive of any species in this area. The deer mouse occurs in every habitat type investigated (Table I-13).

Montane Vole, Meadow Vole, and Sagebrush Vole. Laboratory identification has only recently been made of the first two species. As a result, statistics on population dynamics in this progress report include data on both species as Microtus spp. Because of the overall low numbers of individuals marked, population estimates for Microtus spp. are tentative at this time. The estimate at site 1 is approximately 1.2 animals per acre. No voles have been captured at site 2.

The absence of a vole population at site 2 is probably due to a lack of suitable mountain grassland habitat. Pinyon-juniper overstory at site 2 precludes the development of grass cover in any appreciable amount. The specific habitat preference for mountain grassland is further exemplified in satellite grids where voles were captured in only two plots (Table I-13). Both of these plots were in areas of moist grasslands. The sample of voles captured at site 1 were later identified as the montane vole. The meadow vole was the dominant vole collected along Piceance Creek. It appears that where these two voles occur together the montane vole prefers more arid habitats and the meadow vole prefers the wetter grassy habitats. The sagebrush vole is uncommon in Colorado and has not been collected previously in Rio Blanco County (Lechleitner, 1969). One female was collected at site 1 in the chained pinyon-juniper vegetation. These voles are known to feed on sagebrush in arid habitats so their presence is not surprising.

Other species of small rodents that were trapped will be discussed in future progress reports. Because of low density, more data will be required before comments on population dynamics can be made.

Species composition to date at trap sites 1 and 2 are shown on Tables I-8 through I-13. Eight species of small mammals have been live-trapped at site 1 (this includes the recently identified sagebrush vole, Lagurus curtatus) as opposed to six species at site 2. The two species present at site 1 and not at site 2 are the montane vole (Microtus montanus) and the sagebrush vole. The former is an inhabitant of mountain grassland associations not highly developed at site 2, while the latter is restricted to sagebrush habitat. The Colorado chipmunk occurs at site 2 although it is not reported in the tables. This chipmunk prefers forested areas such as the pinyon-juniper woodland of site 2 to the open area of site 1. At site 1 the capture of this species has occurred close to the pinyon-juniper woodlands to the west. The desert cottontail (Sylvilagus audubonii) is present at both sites although it has been trapped only at site 1. The deer mouse (Peromyscus maniculatus) is the most abundant species at sites 1 and 2, followed by the least chipmunk. Of the 1010 total captures at site 1 and 810 total captures at site 2, the deer mouse comprises 50 percent and 74 percent of the captures, respectively, while the least chipmunk accounts for 39 percent and 22 percent of the total captures, respectively. Both species together account for 89 percent and 96 percent of the total rodents live-trapped at sites 1 and 2. The other species listed in Tables I-8 through I-11 are not significant in terms of abundance at these two sites.

Trap results from the satellite grids also show that the deer mouse and least chipmunk are the abundant small rodents. In the riparian habitat and lower Cottonwood Gulch, however, the least chipmunk was not captured in September or November (Tables I-12 and I-13). Trap results from the satellite grids have added two species to the small-rodent list, the vagrant shrew (Sorex vagrans) and the meadow vole (Microtus pennsylvanicus) both from the Piceance Creek/Willow Creek areas.

Overall trapping success at site 1, measured as the total animals captured over the total trap nights, was 42 percent in August and 51 percent in September. At site 2 overall trapping success was 30 percent in August and 45 percent in September. The increase in the activity and numbers of deer mice and chipmunks accounts for this success. Visual observations in October indicated that many chipmunks were preparing for winter by decreasing their activity. Deer mouse activity was still high as revealed in the November satellite grid results, and should continue through the winter.

The numbers of deer mice and chipmunks and other rodents marked to date at sites 1 and 2 total 143 and 145 respectively. Tables I-17 and I-18 indicate the percent and total captures through September.

Table I-19 lists the terrestrial vertebrate species which occur in the Tract C-b area.

Quantification of food items and food intake will commence in the spring. More intensive work on ectoparasites will also be initiated then. The preliminary ectoparasite data collected this fall show that fleas representing two families parasitize deer mice and chipmunks. It is known, however, that several species of mites, fleas, ticks, lice, and diptera are parasitic on the genera of small rodents present on Tract C-b (Hansen, 1964).

Birds

Strip Census Results. The strip census results for Transects 1 through 8 are presented below.

Transect 1 (Collins Gulch). This plot was quantitatively surveyed during early fall. At that time, the mountain bluebird was the only species observed along the 800-m transect (Table I-20). Qualitative inventories were also made of the Collins Gulch plot early in October, and horned larks, tree sparrows and white-crowned sparrows were observed. Qualitative observations in late fall revealed only the white-crowned sparrow.

Table I-17. CAPTURE-RECAPTURE HISTORY OF MARKED RODENTS ON QUANTITATIVE TRAP GRIDS AT SITE 1 CHAINED PINYON-JUNIPER*

Species	Aug. 1974 New Marks	Sept. 1974 Number Recaptured	Sept. 1974 % Recapture	Sept. 1974 New Marks	Sept. 1974 Total Marked Captures
SCIURIDAE					
Eutamias minimus	19	7	36.8	29	36
Spermophilus lateralis	--	-	--	--	--
CRICETIDAE					
Microtus montanus	6	2	33.3	7	9
Neotoma cinerea	1	0	0.0	4	4
Peromyscus maniculatus	32	5	15.6	45	50
TOTAL	58			85	
TOTAL MARKED	143				

*Animals captured on dense lines only are not included.

Table I-18. CAPTURE-RECAPTURE HISTORY OF MARKED RODENTS ON QUANTITATIVE TRAP GRIDS AT SITE 2 PINYON-JUNIPER*

Species	Aug. 1974 New Marks	Sept. 1974 Number Recaptured	Sept. 1974 % Recapture	Sept. 1974 New Marks	Sept. 1974 Total Marked Captures
SCIURIDAE					
Eutamias minimus	10	6	60.0	28	34
Spermophilus lateralis	1	0	0.0	1	1
CRICETIDAE					
Microtus montanus	--	-	--	--	--
Neotoma cinerea	1	0	0.0	--	--
Peromyscus maniculatus	41	11	26.8	63	74
TOTAL	53			92	
TOTAL MARKED	145				

*Animals captured on dense lines only are not included.

Table I-19. MAMMALS* PRESENT ON OR AROUND TRACT C-b

Scientific Name	Common Name
Canis latrans	Coyote
Castor canadensis	Beaver
Cervus canadensis	Elk
Erethizon dorsatum	Porcupine
Eutamias minimus	Least chipmunk
Eutamias quadrivittatus	Colorado chipmunk
Eutamias umbrinus	Uinta chipmunk
Lagurus curtatus	Sagebrush vole
Lepus townsendii	White-tailed jack rabbit
Lynx rufus	Bobcat
Marmota flaviventris	Yellow-bellied marmot
Mephitis mephitis	Striped skunk
Microtus montanus	Montane vole
Microtus pennsylvanicus	Meadow vole
Mustela erminea	Ermine
Mustela frenata	Long-tailed weasel
Neotoma cinerea	Bushy-tailed wood rat
Odocoileus hemionus	Mule deer
Ondatra zibethicus	Muskrat
Perognathus apache	Apache pocket mouse
Peromyscus maniculatus	Deer mouse
Procyon lotor	Raccoon
Sorex cinerea	Masked shrew
Sorex vagrans	Vagrant shrew
Spermophilus lateralis	Golden-mantled ground squirrel
Spermophilus tridecemlineatus	Thirteen-lined ground squirrel

*Identified by sighting, live-trap, sign, etc.

Table I-19. (Concluded)

Scientific Name	Common Name
Sylvilagus audubonii	Desert cottontail
Taxidea taxus	American badger
Thomomys (talpoides?)	Pocket gopher
Urocyon cinereoargenteus	Gray fox

Table I-20. ABSOLUTE DENSITIES OF BIRD SPECIES AT TRACT C-b, TRANSECT 1, COMPUTED FROM EMLEN STRIP CENSUS CONDUCTED OCTOBER 8, 1974

Species	Method of Estimation*	Number Observed	Density**	% Rel. Density***
Mountain bluebird	A	1	5	100.0
TOTAL		1	5	100.0

* See Methods and Materials and Figure I-6 for an explanation of the particular calculations of density indicated by A, B or C.

** Density in birds/km^2 of appropriate habitat.

***Percentage Relative Density was calculated as

$$\% \text{ Relative Density} = \frac{\text{Density of Species A}}{\Sigma \text{ Density of all Species}} \times 100$$

Transect 2 (Oldland Ranch/Piceance Creek). The variety of birds occupying this plot during the migratory and post-migratory season is indicative of the heterogeneity of habitat along the creek; many species found are usually associated with riparian or nonwoodland habitats (Tables I-21 and I-22). The red-winged blackbird and song sparrow are birds typically associated with streams and pasture land. The Douglas fir trees attracted Townsend's solitaire and yellow-rumped warblers. The stream was responsible for the presence of green-winged teal, while mourning doves were associated with the dense vegetation along the transect's southeastern edge.

Small rodent species inhabiting the pasture community probably invited the presence of the red-tailed hawk and marsh hawk. During October, species attaining greatest density and contributing most to relative density of this bird community were: the mourning dove, red-winged blackbird, and white-crowned sparrow. Combined, these three species contributed 80 percent to the total bird density of the census route. During late November, the American robin, starling, and song sparrow contributed 87 percent to the community's density. These, then, are the important species in this spectrum of habitats during the fall.

Transect 3 (West Fork Stewart Gulch). The bird community in this area was comprised of species responding to either the sagebrush-rabbitbrush habitat or to the pinyon-juniper cover on the adjacent sandstone slopes (Tables I-23 and I-24). The rocky slopes were inhabited by canyon wrens and rock wrens. Mountain bluebirds, Townsend's solitaire, and yellow-rumped warblers utilized all habitat types, while the black-capped chickadee and white-crowned sparrow were more restricted to the rabbit-brush. The Steller's jay and black-billed magpies were associated primarily with the surrounding pinyon-juniper trees. In late fall the habitat was visited by the northern shrike. In terms of relative density, the mountain bluebird and Townsend's solitaire contributed

Table I-21. ABSOLUTE DENSITIES OF BIRD SPECIES AT TRACT C-b, TRANSECT 2, COMPUTED FROM EMLEN STRIP CENSUS CONDUCTED OCTOBER 8, 1974*

Species	Method of Estimation	Number Observed	Density	% Rel. Density
Green-winged teal	A	2	10	0.5
Red-tailed hawk	A	1	5	0.3
Marsh hawk	A	1	5	0.3
Mourning dove	B	11	808	41.7
Black-billed magpie	A	4	21	1.1
American robin	A	1	5	0.3
Townsend's solitaire	B	1	5	0.3
Starling	A	1	5	0.3
Yellow-rumped warbler	A	3	15	0.7
Red-winged blackbird	A	61	314	16.2
White-crowned sparrow	B	20	412	21.3
Song sparrow	B	4	330	17.0
TOTAL		110	1935	100.0

Table I-22. ABSOLUTE DENSITIES OF BIRD SPECIES AT TRACT C-b, TRANSECT 2, COMPUTED FROM EMLEN STRIP CENSUS CONDUCTED NOVEMBER 22, 1974*

Species	Method of Estimation	Number Observed	Density	% Rel. Density
Red-tailed hawk	A	1	5	0.4
American robin	A	86	441	33.8
Starling	A	48	246	18.8
White-crowned sparrow	B	4	164	12.5
Song Sparrow	B	11	451	34.5
TOTAL		150	1307	100.0

*See Table I-20 for a description of Methods of Estimation, Density, and Percentage Relative Density.

Table I-23. ABSOLUTE DENSITIES OF BIRD SPECIES AT TRACT C-b, TRANSECT 3, COMPUTED FROM EMLEN STRIP CENSUS CONDUCTED OCTOBER 9, 1974*

Species	Method of Estimation	Number Observed	Density	% Rel. Density
Steller's jay	B	1	5	2.2
Black-capped chickadee	B	1	21	9.3
Rock wren	B	2	10	4.4
Mountain bluebird	A	21	108	47.8
Townsend's solitaire	B	9	46	20.4
Yellow-rumped warbler	A	3	15	6.6
White-crowned sparrow	B	2	21	9.3
TOTAL		39	226	100.0

Table I-24. ABSOLUTE DENSITIES OF BIRD SPECIES AT TRACT C-b, TRANSECT 3, COMPUTED FROM EMLEN STRIP CENSUS CONDUCTED NOVEMBER 22, 1974*

Black-billed magpie	A	2	10	66.7
Northern shrike	A	1	5	33.3
TOTAL		3	15	100.0

* See Table I-20 for a description of Methods of Estimation, Density, and Percentage Relative Density.

68.2 percent of all individuals present in this habitat in early October, while the black-billed magpie and northern shrike occupied 100 percent of the transect in late November. Clearly, mountain bluebirds and Townsend's solitaires are important in this habitat during the migration period, while no particular species was present in substantial numbers during late fall.

Transect 4 (Mammal Plot No. 2). Species diversity and overall density were low in this homogeneous pinyon-juniper woodland when compared to census routes through more heterogeneous habitat types (Tables I-25 and I-26).

Bird distribution in woodlands is usually not determined by the species of trees per se, but by the structural appearance (physiognomy) provided by the vegetative community (Bond, 1957; Hilden, 1965). The number of vegetative strata comprising a woodland is normally an important determinant of bird species diversity. It is not surprising, then, to find a low number of species occupying Transect 4. The black-capped chickadee, white-breasted nuthatch, mountain bluebird, and Townsend's solitaire are generally considered to be associated with large wooded areas on Colorado's western slope. Townsend's solitaire, which accounted for 67 percent (mid-fall) and 60 percent (late-fall) relative density is an important species in this ecosystem.

Transect 5 (Middle Sorghum Gulch). This plot within a mature but sparse stand of pinyon-juniper, showed a poor species richness in early October. Table I-27 tallies species composition and relative density for the transect. The two species found were observed in low numbers and density estimations are only approximate. Both the Townsend's solitaire and gray-headed junco are expected to utilize this habitat through the winter season. No major migratory activity was apparent at this plot during the census period.

Table I-25. ABSOLUTE DENSITIES OF BIRD SPECIES AT TRACT C-b, TRANSECT 4, COMPUTED FROM EMLEN STRIP CENSUS CONDUCTED OCTOBER 9, 1974*

Species	Method of Estimation	Number Observed	Density	% Rel. Density
Black-capped chickadee	B	1	21	22.4
American robin	A	1	5	5.3
Mountain bluebird	A	1	5	5.3
Townsend's solitaire	B	5	63	67.0
TOTAL		8	94	100.0

Table I-26. ABSOLUTE DENSITIES OF BIRD SPECIES AT TRACT C-b, TRANSECT 4, COMPUTED FROM EMLEN STRIP CENSUS CONDUCTED NOVEMBER 22, 1974*

Species	Method of Estimation	Number Observed	Density	% Rel. Density
White-breasted nuthatch	B	2	10	40.0
Townsend's solitaire	B	3	15	60.0
TOTAL		5	25	100.0

*See Table I-20 for a description of Methods of Estimation, Density, and Percentage Relative Density.

Table I-27. ABSOLUTE DENSITIES OF BIRD SPECIES AT TRACT C-b, TRANSECT 5, COMPUTED FROM EMLEN STRIP CENSUS CONDUCTED OCTOBER 9, 1974*

Species	Method of Estimation	Number Observed	Density	% Rel. Density
Townsend's solitaire	B	3	15	60.0
Gray-headed junco	B	1	10	40.0
TOTAL		4	25	100.0

*See Table I-20 for a description of Methods of Estimation, Density, and Percentage Relative Density.

Transect 6 (Mammal Plot No. 1). This habitat of chained pinyon-juniper supported only five species during the two censuses (Tables I-28 and I-29). No species dominated during the fall. Although the gray-headed junco contributed over 50 percent of the relative density in October it was not found on the route during November. This junco is a flocking species which can wander from habitat to habitat through its winter residence on the tract. Both the mountain bluebird and yellow-rumped warbler, observed in October, had migrated farther south by late November. Only the Townsend's solitaire was recorded during both census periods. The five bird species occupying this plot, with the exception of the American robin, are considered typical of this habitat type.

Transect 7 (Vegetation Site 3). No birds were observed or heard within the transect strip through this upland sagebrush community during the October census. A flock of more than 200 horned larks was observed within this habitat during qualitative surveys. Other species are expected to utilize this area occasionally through fall and winter, appearing in transient flocks.

Transect 8 (Willow Creek). Bird distribution and abundance within this zone of mountain brush reflected the sparseness typical of temperate areas during mid-fall. Table I-30 presents results of the early October census. Only three species were found; the mountain chickadee and ruby-crowned kinglet were most abundant. The few species observed were not, however, representative of the expected composition-density of mid-fall migration. This suggests that the bulk of migration had passed, or that the census period occurred at a low point in migrational waves.

Upland Game Birds. Few upland game birds were observed. It is, however, premature to speculate on the seasonal abundance of species on Tract C-b from only one season's observations. General information presently available for this portion of the Piceance Basin, coupled with initial appraisals of the tract's habitat suitability, forms the basis for preliminary discussion.

Table I-28. ABSOLUTE DENSITIES OF BIRD SPECIES AT TRACT C-b, TRANSECT 6, COMPUTED FROM EMLEN STRIP CENSUS CONDUCTED OCTOBER 10, 1974*

Species	Method of Estimation	Number Observed	Density	% Rel. Density
Mountain bluebird	A	4	20	10.9
Townsend's solitaire	B	4	41	22.3
Yellow-rumped warbler	A	3	20	10.9
Gray-headed junco	B	5	103	55.9
TOTAL		16	184	100.0

Table I-29. ABSOLUTE DENSITIES OF BIRD SPECIES AT TRACT C-b, TRANSECT 6, COMPUTED FROM EMLEN STRIP CENSUS CONDUCTED NOVEMBER 22, 1974*

Species	Method of Estimation	Number Observed	Density	% Rel. Density
American robin	A	1	5	50.0
Townsend's solitaire	B	1	5	50.0
TOTAL		2	10	100.0

*See Table I-20 for a description of Methods of Estimation, Density, and Percentage Relative Density.

Table I-30. ABSOLUTE DENSITIES OF BIRD SPECIES AT TRACT C-b, TRANSECT 8, COMPUTED FROM EMLEN STRIP CENSUS CONDUCTED OCTOBER 10, 1974*

Species	Method of Estimation	Number Observed	Density	% Rel. Density
Western flycatcher	B	1	41	16.5
Mountain chickadee	B	6	124	49.8
Ruby-crowned kinglet	B	4	84	33.7
TOTAL		11	249	100.0

*See Table I-20 for a description of Methods of Estimation, Density, and Percentage Relative Density.

Sage Grouse. Rogers (1964) describes sage grouse density in the region as "light" and indicates that this grouse has been observed in only scant numbers southeast of the Tract. We found little satisfactory habitat for sage grouse on Tract C-b proper, and do not anticipate finding leks or nesting concentrations on the lease.

Blue Grouse. Blue grouse habitat appears restricted to points southeast of the Tract. This coincides with Roger's (1968) estimation of scattered population at the higher elevations of the Cathedral Bluffs and the Book Plateau. There was some evidence of blue grouse directly south of the lease, but none were seen during October and November.

Mourning Doves. During early October, mourning doves were observed on transect 2. We believe that most doves had left Tract C-b by the time of the October censuses. Habitat in the tract vicinity should support many nesting pairs during the breeding season and strip transects made at that time will provide numbers and distribution of this dove.

Waterfowl. Results from the two sampling periods indicate that significant use of the tract by waterfowl is restricted to the P-L Ranch pond. The October and November surveys verified seven species of waterfowl resting and feeding on this impoundment. During October, diversity and relative abundance (Table I-31) was dominated by mallards, green-winged teal and blue-winged teal, while mallards and green-winged teal comprised the largest portion of waterfowl for November (Table I-32). To achieve a fuller picture, waterfowl utilization in bird-use-days was calculated. Results for this quarter are tallied in Table I-33.

Raptorial Birds. The occurrence of nine raptor species was documented during both sampling periods. Red-tailed hawk, rough-legged hawk, golden eagle, marsh hawk, and American kestrel comprise the diurnal species noted (Table I-34), while the barn owl, screech owl, great-horned owl, and long-eared owl were recorded during night counts conducted November 21 and 22.

Table I-31. RELATIVE ABUNDANCE OF WATERFOWL SPECIES ON THE P-L RANCH POND, AS COMPUTED FROM SURVEYS CONDUCTED OCTOBER 9 AND 10, 1974

Species	Number Observed	% Relative Abundance*
Mallard	178	64.2
Green-winged teal	29	10.5
Blue-winged teal	54	19.5
American widgeon	8	2.8
Northern shoveler	2	0.7
American coot	6	2.3
TOTAL	277	100.0

Table I-32. RELATIVE ABUNDANCE OF WATERFOWL SPECIES ON THE P-L RANCH POND, AS COMPUTED FROM SURVEYS CONDUCTED NOVEMBER 22, 1974

Species	Number Observed	% Relative Abundance*
Mallard	38	42.2
Gadwall	2	2.3
Green-winged teal	42	46.6
Blue-winged teal	2	2.3
American coot	6	6.6
TOTAL	90	100.0

*Percentage Relative Abundance was calculated as

$$\% \text{ Relative Abundance} = \frac{\text{Number of Species A}}{\text{Sum of all Species}} \times 100$$

Table I-33. WATERFOWL UTILIZATION ON THE P-L RANCH POND COMPUTED FROM FALL CENSUSES, 1974

October 9			October 10			November 22		
Species	Number Recorded	Bird-use Days*	Species	Number Recorded	Bird-use Days*	Species	Number Recorded	Bird-use Days*
Mallard	53	26.5	Mallard	125	31.1	Mallard	38	12.7
Green-winged teal	5	2.5	Green-winged teal	24	6.0	Gadwall	2	0.7
Blue-winged teal	26	13.0	Blue-winged teal	28	7.0	Green-winged teal	42	14.0
American coot	3	1.5	American widgeon	8	2.0	Blue-winged teal	2	0.7
			Northern shoveler	2	0.5	American widgeon	8	2.7
			American coot	3	0.8	American coot	6	2.0
TOTAL	87	43.5		190	47.7		98	32.8

*Total Bird-use days calculated as

$$\text{Bird-use days} = \frac{\text{Average or mean sum of species recorded/day}}{\text{Total number of observations/day}}$$

Table I-34. RELATIVE ABUNDANCE OF RAPTORIAL SPECIES ON TRACT C-b AS COMPUTED FROM FIELD INVESTIGATIONS DURING FALL OF 1974

OCTOBER			NOVEMBER		
Species	Number Observed	% Relative Abundance*	Species	Number Observed	% Relative Abundance*
Red-tailed hawk	3	15.0	Red-tailed hawk	3	30.0
Golden eagle	7	35.0	Rough-legged hawk	2	20.0
Marsh hawk	9	45.0	Golden eagle	1	10.0
American kestrel	1	5.0	Marsh hawk	3	30.0
			American kestrel	1	10.0
TOTAL	20	100.0		10	100.0

*Percentage Relative Abundance was calculated as

$$\% \text{ Relative Abundance} = \frac{\text{Number of Species A}}{\text{Sum of All Species}} \times 100$$

Red-tailed hawks were sighted six times during October and November. A pair was seen actively hunting east of the Walter Oldland Ranch during both census periods.

Rough-legged hawks had migrated into the area by late November. They are expected to remain in the vicinity in moderate numbers through the winter.

Eight separate sightings of golden eagles were recorded during the fall, and on two occasions a pair was observed hunting over the tract proper. Others were observed in the immediate vicinity of the lease.

Marsh hawks, the most common raptor encountered, were found exclusively along the valley of Piceance Creek. A high density of small rodents in the pasture land bordering the stream may account for their high numbers.

American kestrels were observed in Cottonwood Gulch on October 8. A single male was seen near the P-L Ranch entrance road on November 22, several weeks after its expected migratory departure date (Bent, 1961).

Since nest locations indicate the specific habitat preferences of a species, all eyries and former raptor nesting locations encountered during ground activities were recorded, photographed and plotted on maps. Figure I-7 depicts locations of nine nest sites (Table I-35) discovered.

Mr. Gerald Craig, Chief Raptor Biologist for the Colorado Division of Wildlife, provided information on raptorial species utilizing habitats or residing on Tract C-b and adjacent areas. Two of the nine sites located (numbers 4 and 6) are known to be golden eagle nests. Both sites have produced eaglets once during the past three years.

During late May 1975 Tract C-b and its environs will be traversed in its entirety to locate nest sites and make a count of breeding raptors.

Results of the two night owl road transects allow a ranking of relative abundance for nocturnal raptor species on Tract C-b; moreover,

Table I-35. RAPTOR NESTS LOCATED ON AND AROUND TRACT C-b DURING FALL FIELD INVESTIGATIONS

Species	Nest Location
unknown	SW¼ of Sec. 27, T3S, R97W
unknown	SW¼ of Sec. 14, T3S, R97W
unknown	SW¼ of Sec. 2, T3S, R97W
Golden eagle	NW¼ of Sec. 2, T3S, R97W
unknown	SE¼ of Sec. 8, T3S, R96W
Golden eagle	SW¼ of Sec. 9, T3S, R96W
unknown	SE¼ of Sec. 15, T3S, R96W
unknown	NW¼ of Sec. 12, T3S, R97W
unknown	SE¼ of Sec. 8, T3S, R96W

Table I-36. RELATIVE ABUNDANCE OF OWL SPECIES ON TRACT C-b AS COMPUTED FROM FIELD INVESTIGATIONS CONDUCTED NOVEMBER 21 AND 22, 1974

Species	Number Recorded	% Relative Abundance*
Barn owl	1	12.5
Screech owl	2	25.0
Great horned owl	3	37.5
Long-eared owl	2	25.0
TOTAL	8	100.0

*Percentage Relative Abundance was calculated as

$$\% \text{ Relative Abundance} = \frac{\text{Number of Species A}}{\text{Sum of all Species}} \times 100$$

they provide information on species that will probably go unnoted during the Emlen strip transects, or that live in areas away from the intensively censused plots. Relative abundance of each species is shown in Table I-36.

The barn owl was the only raptorial species observed which should tentatively be considered unusual for this portion of western Colorado. A single individual was observed perched on a fence post 0.35 km southeast of the Walter Oldland Ranch at stop number 28 on November 22. A few sight records of this owl exist for western Colorado and northeast Utah (Gilman, 1907; Twomey, 1942). Davis (1969) does not assign this species a status, and indicates no recent known records. The distribution of home dwellings along Piceance Creek and the barn owl's preference for such habitations may account in part for its presence in this area.

Species Listing. Species of birds utilizing or residing in habitats on Tract C-b are listed in Table I-37. A total of 57 species were tallied during the two fall inventories. Emlen strip transects accounted for 21 species, while qualitative field inventories within a variety of tract habitats showed 26 species. Waterfowl surveys and night owl counts added an additional 11 species.

No rare or endangered species of birds as defined by the U.S. Bureau of Sport Fisheries and Wildlife (1973) were observed on Tract C-b during either sampling period. Observation will continue through all field periods.

Prairie falcons (Falco mexicanus) and anatum peregrine falcons (Falco peregrinus anatum), both officially listed as endangered species, are considered rare resident breeders in northwest Colorado (Bailey and Niedrach, 1967; Davis, 1969). Gerald Craig (personal communication) noted that both species have nested and fledged young from eyries in northwest Colorado, and are possible residents in areas south of Tract C-b. Enderson and Craig's (1974) treatise on the status of the peregrine falcon in the Rocky Mountains demonstrates a population reduction over

Table I-37. SPECIES OF BIRDS OBSERVED DURING FALL FIELD INVESTIGATIONS AT TRACT C-b

Scientific Name	Common Name
Anas platyrhynchos	Mallard
Anas strepera	Gadwall
Anas crecca	Green-winged teal
Anas discors	Blue-winged teal
Anas americana	American widgeon
Anas clypeata	Northern shoveler
Buteo jamaicensis	Red-tailed hawk
Buteo lagopus	Rough-legged hawk
Aquila chrysaetos	Golden eagle
Circus cyaneus	Marsh hawk
Falco sparverius	American kestrel
Fulica americana	American coot
Zenaida macroura	Mourning dove
Tyto alba	Barn owl
Otus asio	Screech owl
Bubo virginianus	Great horned owl
Asio otus	Long-eared owl
Colaptes auratus	Common flicker
Dendrocopos villosus	Hairy woodpecker
Empidonax difficilis	Western flycatcher
Eremophila alpestris	Horned lark
Hirundo rustica	Barn swallow
Petrochelidon pyrrhonota	Cliff swallow
Cyanocitta stelleri	Steller's jay
Aphelocoma coerulescens	Scrub jay
Gymnorhinus cyanocephalus	Pinyon jay
Pica pica	Black-billed magpie
Corvus corax	Common raven

Table I-37. (Concluded)

Scientific Name	Common Name
Corvus brachyrhynchos	Common crow
Nucifraga columbiana	Clark's nutcracker
Parus atricapillus	Black-capped chickadee
Parus gambeli	Mountain chickadee
Sitta carolinensis	White-breasted nuthatch
Sitta canadensis	Red-breasted nuthatch
Troglodytes aedon	House wren
Catherpes mexicanus	Canyon wren
Salpinctes obsoletus	Rock wren
Oreoscoptes montanus	Sage thrasher
Turdus migratorius	American robin
Sialia currucoides	Mountain bluebird
Myadestes townsendi	Townsend's solitaire
Regulus calendula	Ruby-crowned kinglet
Lanius excubitor	Northern shrike
Sturnus vulgaris	Starling
Dendroica coronata	Yellow-rumped warbler
Strunella neglecta	Western meadowlark
Agelaius phoeniceus	Red-winged blackbird
Euphagus cyanocephalus	Brewer's blackbird
Carpodacus mexicanus	House finch
Spinus pinus	Pine siskin
Spinus tristis	American goldfinch
Passerculus sandwichensis	Savannah sparrow
Pooecetes gramineus	Vesper sparrow
Junco caniceps	Gray-headed junco
Spizella arborea	Tree sparrow
Zonotrichia leucophrys	White-crowned sparrow
Melospiza melodia	Song sparrow

the last few decades through declining reproduction. Although likely eyrie sites appear to be restricted to points south of the lease, if the peregrine falcon resides on or utilizes habitats on Tract C-b, it should be encountered and documented during the remaining census periods or raptor surveys.

Preliminary Interpretations. The October sampling period appears to have fallen near the end of fall migration for most songbirds. Some species of migrant birds, such as the barn swallow, cliff swallow, house wren and western flycatcher, were still present. Other species generally considered as mid-to-late-migrants, such as the mourning dove, mountain bluebird and red-winged blackbird, were also present.

November's census exemplified the uneven pattern of bird distribution typical of temperate regions during late fall. Migratory species encountered in October had departed from the Tract C-b region while more northern migratory species, such as the rough-legged hawk and northern shrike, had migrated into the area.

Results of any census of birds made during this period must be viewed with cognizance of certain basic characteristics of bird migration. During migration, many nocturnally migrating species stop their directional movement each morning to feed and rest in loosely organized flocks; these flocks move along topographical features such as drainages, and the species comprising them exhibit a much less specific attachment to particular favored habitats than they exhibit during breeding season. Therefore, bird distribution during periods of migration is often highly clumped or aggregated, and large areas of seemingly appropriate habitat will support no birds at a given moment while a relatively small area may contain extremely high densities of birds. As a consequence, bird density estimates made during migration periods are not directly comparable for long-term periods.

Moreover, species composition during migration is dynamic within a region, and a wave of one migrant species can quickly be replaced by a wave of another species. Densities can also vary markedly day to day during migration, as bird numbers build up in an area when poor weather stalls advance, and then decline abruptly when favorable weather conditions promote exodus. This dependency of migratory dynamics on weather conditions has been well documented (Curtis, 1969a, 1969b; Hassler et al., 1963). The exact path a flock takes and the location of a stopping point along the migratory route may also be determined by the extent to which the flock is displaced by winds (Graber, 1968). Cold temperatures are a major influence on migration during autumn (Lack, 1960).

Results obtained from the early October and late November surveys are basically those expected. Significant aspects of species composition and density for the Tract C-b region will become clearer through comparison of observed conditions with more lengthy studies reported in the literature, and with other investigations being conducted in the general area. Such interpretations will be included in the annual report. Winter and summer periods will be the most important to consider.

Reptiles and Amphibians

Because of the late start of the field program, no quantitative work was attempted with reptiles and amphibians. It appeared, however, that the sagebrush lizard (Sceloporus graciosus) is very common on Tract C-b, especially in the chained pinyon-juniper areas. The short-horned lizard (Phrynosoma douglassi) was not as common. More definitive work will commence in the spring of 1975.

Arthropods

Arthropods Other Than Soil Arthropods. Arthropods representing three classes, 14 orders, and 50 families (Table I-38) were identified from preliminary collections on Tract C-b during September 1974. Such a high

Table I-38. ARTHROPODS COLLECTED ON TRACT C-b (SEPTEMBER 1974)

Scientific Name	Common Name
DIPLOPODA	Millipedes
INSECTA	
THYSANURA	
Machilidae	Jumping bristletails
COLLEMBOLA	
Entomobryidae	Springtails
Sminthuridae	Springtails
ORTHOPTERA	
Acrididae	Short-horned grasshoppers
Tettigoniidae	Long-horned grasshoppers
Gryllacrididae	Crickets
Gryllidae	Crickets
PSOCOPTERA	
Trogiidae	Trogiid booklice
THYSANOPTERA	
Phloeothripidae	Thrips
HEMIPTERA	
Anthocoridae	Minute pirate bugs
Miridae	Plant bugs
Reduviidae	Assassin bugs
Nabidae	Damsel bugs

Table I-38 (Continued)

Scientific Name	Common Name
HOMOPTERA	
Cicadellidae	Leafhoppers
Psyllidae	Psyllids
Aphididae	Aphids
COLEOPTERA	
Carabidae	Ground beetles
Silphidae	Carrion beetles
Staphylinidae	Rove beetles
Coccinellidae	Ladybird beetles
Chrysomelidae	Leaf beetles
Curculionidae	Snout beetles
DIPTERA	
Culicidae	Mosquitos
Cecidomyiidae	Gall gnats
Dolichopodidae	Long-legged flies
Phoridae	Humpbacked flies
Syrphidae	Syrphid flies
Tephritidae	Fruit flies
Calliphoridae	Blow flies
SIPHONAPTERA	Fleas
HYMENOPTERA	
Braconidae	Braconid wasp
Chalcidoidea	Chalcid wasps
Mutillidae	Velvet ants

Table I-38 (Concluded)

Scientific Name	Common Name
Formicidae	Ants
Pompilidae	Spider wasps
ARACHNIDA	
PHALANGIDA	
Phalangiidae	Daddy-longlegs
ACARINA	
Tetranychiidae	Spider mites
ARANEIDA	
Dictynidae	Spider
Gnaphosidae	Hunting spiders
Pholicidae	Long-legged spiders
Clubionidae	Two-clawed hunting spiders
Thomisidae	Crab spiders
Salticidae	Jumping spiders
Agelenidae	Funnel-webbed spiders
Hahniidae	Hahniid spiders
Lycosidae	Wolf spiders
Oxyopidae	Lynx spiders
Araneidae	Orb-weavers
Micryphantidae	Dwarf spiders

diversity, at a time of year when many arthropods are neither abundant nor active, indicates that many additional families will be collected during optimum collecting periods (Spring and Summer) in 1975.

The relative abundance of arthropod populations were compared in the two major vegetation types and among five common shrubs found on Tract C-b. Analysis of data from the pit can traps (Table I-39) indicates that the chained pinyon-juniper vegetation may support a more diverse arthropod fauna than pinyon-juniper. Twice as many families (26 vs. 13) were collected in the chained pinyon-juniper area. This increase in kinds of arthropods may be related to the larger number of shrubs in the chained area. Analysis of data to be collected in 1975 should reveal whether this is a long-term trend.

The relative abundance of arthropods was also found to vary with the species of shrub sampled (Table I-40). From the limited number found on shrubs in September it appears that serviceberry (Amelanchier alnifolia), big sagebrush (Artemisia tridentata), and pinyon pine (Pinus edulis) support the most families of arthropods. At least eight families of arthropods were collected on these three shrubs while only four families were found on mountain mahogany (Cercocarpus montanus) and only one on snowberry (Symphoricarpos oreophilus). The small number of arthropods on snowberry in September may occur because their leaves senesce earlier than the other shrubs. If this were the case, more arthropods would be expected on a shrub whose leaves drop later. This may explain why big sagebrush, which is known to retain many of its leaves through the winter, supports greater numbers and more families. Very few arthropods were found on mountain mahogany. This may be due to the leaves senescing. However, Furniss and Krebill (1972), in their studies on harmful insects of various shrubs on western big game ranges, found mountain mahogany "to be relatively free of attack by insects." The relative lack of arthropod families may be a function of a natural resistance to arthropods. Further sampling in more

Table I-39. ARTHROPODS COLLECTED FROM PIT CAN TRAPS ON TRACT C-b (SEPTEMBER 1974)

Scientific Name	Common Name	Site 1 Chained	Site 2 Pinyon-Juniper
DIPLOPODA	Millipedes	1	
INSECTA			
THYSANURA			
Machilidae	Jumping bristletails	4	4
COLLEMBOLA			
Entomobryidae	Springtails	1	
Sminthuridae	Springtails		1
ORTHOPTERA			
Acrididae	Short-horned grasshoppers	1	
Tettigoniidae	Long-horned grasshoppers	1	
Gryllacrididae	Crickets	3	1
Gryllidae	Crickets	1	
PSOCOPTERA			
Trogiidae	Trogiid booklice	1	
HEMIPTERA			
Reduviidae	Assassin bugs	3	
Nabidae	Damsel bugs	2	
HOMOPTERA			
Cicadellidae	Leafhoppers	1	
COLEOPTERA			
Carabidae	Ground beetles	2	
Chrysomelidae	Leaf beetles	1.	

Table I-39 (Concluded)

Scientific Name	Common Name	Site 1 Chained	Site 2 Pinyon-Juniper
DIPTERA			
Cecidomyiidae	Gall gnats		1
Dolichopodidae	Long-legged flies		1
Phoridae	Humpbacked flies	1	
HYMENOPTERA			
Formicidae	Ants	10	5
Pompilidae	Spider wasps	1	
ARACHNIDA			
PHALANGIDA			
Phalangiidae	Daddy-longlegs	2	3
ACARINA			
Tetranychiidae	Spider mites	1	105
ARANEIDA			
Dictynidae	Spider	1	
Gnaphosidae	Hunting spiders	10	5
Pholcidae	Long-legged spiders		1
Thomisidae	Crab spiders	13	
Agelenidae	Funnel-webbed spiders	3	1
Hahniidae	Hahniid spiders	3	
Lycosidae	Wolf spiders	11	1
Araneidae	Orb-weavers	2	6
Micryphantidae	Dwarf spiders	1	

Table I-40. ARTHROPODS COLLECTED ON HOST PLANTS BY SWEEP NET ON TRACT C-b (SEPTEMBER 1974)

Scientific Name	Common Name	Host Plant: Amelanchier alnifolia	Cercocarpus montanus	Artemisia tridentata	Pinus edulis	Symphoricarpos oreophilus
INSECTA						
THYSANOPTERA						
Phloeothripidae	Thrips	1				
HEMIPTERA						
Anthocoridae	Minute pirate bugs			6		
Miridae	Plant bugs	1		31		
Reduviidae	Assassin bugs		1		3	
HOMOPTERA						
Cicadellidae	Leafhoppers	1		10	3	
Psyllidae	Psyllids		22			
Aphididae	Aphids	6			17	
COLEOPTERA						
Coccinellidae	Ladybird beetles		1	3	3	
Chrysomelidae	Leaf beetles			4		
Curculionidae	Snout beetles				1	
DIPTERA						
Syrphidae	Syrphid flies			1		
Tephritidae	Fruit flies	1				
HYMENOPTERA						
Braconidae	Braconid wasps			1	1	
Chalcidoidea	Chalcid wasps	1		24	10	
Formicidae	Ants				1	3

Table I-40 (Concluded)

Scientific Name	Common Name	Host Plant: Amelanchier alnifolia	Cercocarpus montanus	Artemisia tridentata	Pinus edulis	Symphoricarpos oreophilus
ARACHNIDA						
ARANEIDA						
Thomisidae	Crab spiders		2	3		
Clubionidae	Two-clawed hunting spiders	1				
Salticidae	Jumping spiders	4			1	
Oxyopidae	Lynx spiders			4	2	

favorable seasons should give a better picture of the relationship between arthropod distribution and the shrubs sampled. The number of arthropods is known to rise and fall, oftentimes dramatically, throughout the year. It is expected that some of these seasonal patterns can be discerned once sufficient data are collected.

Arthropods on Tract C-b function as herbivores, insectivores, and scavengers. There are several types of herbivore relationships present. Some arthropods, such as grasshoppers and leaf beetles, eat leaves and tender stems with their chewing mouthparts. Others, such as plant bugs, leafhoppers, and aphids feed by sucking plant juices from various parts of the plant. This feeding can result in discoloration, wilting, stunting or even death. Some, like wasps, attack plants in yet another way by causing galls to be formed.

Some arthopods are insectivores and play important roles in controlling the populations of other arthropods. For example, damsel bugs, assassin bugs, parasitic wasps, several spiders, and many other insectivores feed on or attack other arthropods.

Arthropods play an important role as scavengers on decaying plant and animal matter. Bristletails, springtails, ground beetles, and others feed on decaying vegetation. Carrion beetles, rove beetles, and blowflies feed on decaying animal matter. These arthropods can dispose of a dead mouse in a matter of days. Without these scavengers, the time required for recycling of decaying organic material would be considerably longer.

Arthropods are an integral part of the biological systems on Tract C-b. Their numbers and their diversity of form and habit far exceed those of other animals on the tract. Arthropods function at almost all tropic levels. Complex and important relationships exist between

arthropods and other plants and animals, including other arthropods. These relationships act as a system of checks and balances that help maintain a stable ecosystem.

Soil Arthropods and Microarthropods. From the data of October 15 (Table I-41) it is apparent that Prostigmata mites are most numerous, with Oribatid mites next in population size.

There is little interpretation that can be made from this initial sample. Additional samples will have to be taken and the populations and other factors compared with the initial collection.

The work going on currently involves a sorting into family and other groups. Specimen slides will be made for Atlantic Richfield Company's reference as well as for the investigators' collections.

Soil Fungi and Bacteria

Laboratory results are not yet available.

Table I-41. SOIL ARTHROPODS COLLECTED DURING OCTOBER 1974 ON TRACT C-b

Site	Habitat	Numbers of Soil Arthropod				
		Mesostigmata	Prostigmata	Astigmata	Oribatid	Misc.
C-b-3	Plateau sage	41	2100	7	47	56
C-b-5	Valley sage	9	938	-	103	65
C-b-10-1	Sage & grass	-	914	7	120	143
C-b-10-2	Service berry	8	879	-	318	28
C-b-10-4	Mountain mahogany	2	975	0	57	14
C-b-15-1	Pinyon-juniper	5	1425	2	390	170
C-b-15-2	Service berry	8	2244	10	570	171
C-b-15-3	Mountain mahogany	4	1986	34	266	21

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Aquatic Studies

II

AQUATIC STUDIES

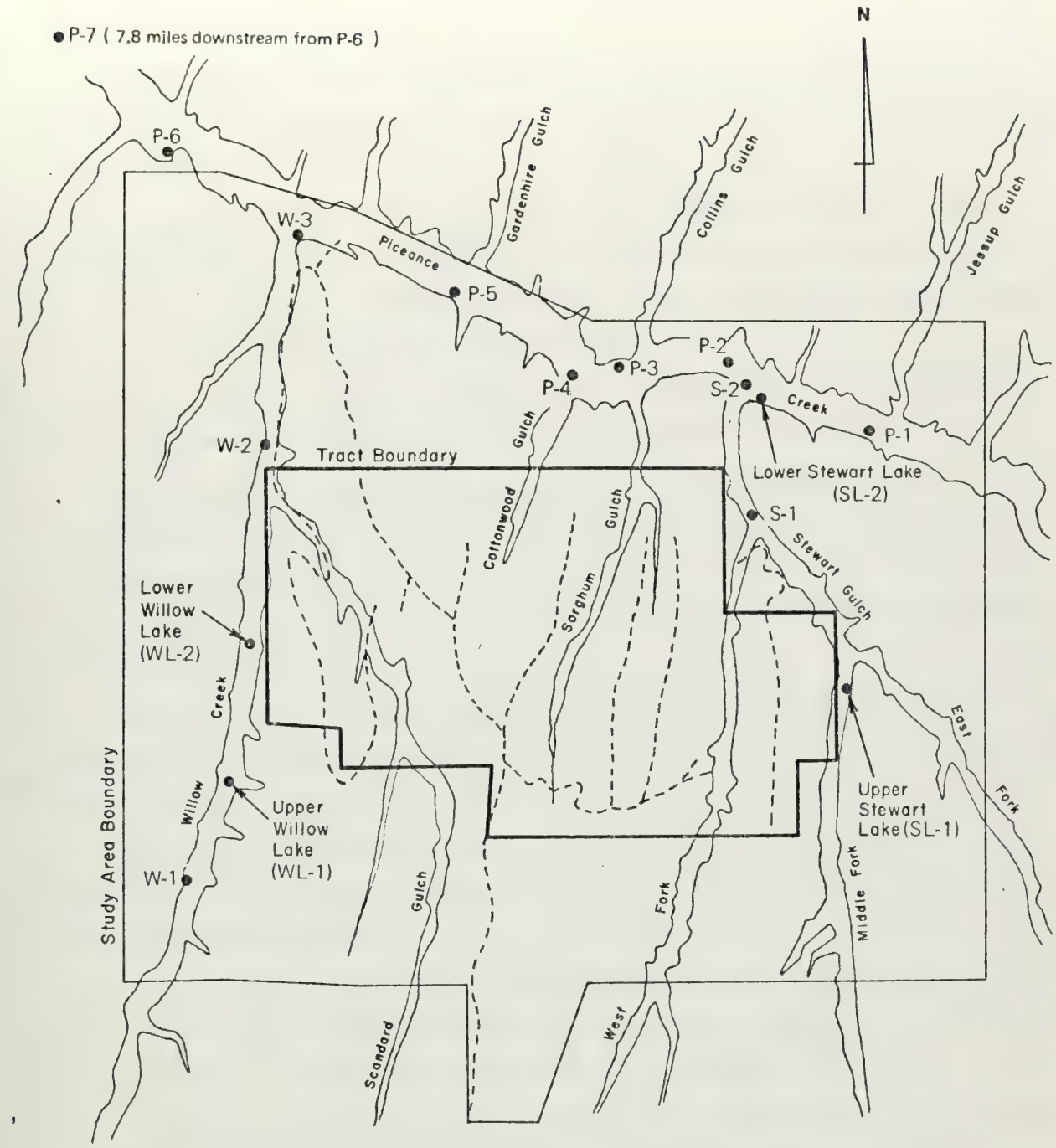
The purpose of the aquatic baseline studies is to gather sufficient data about the functioning of the aquatic ecosystem to meet federal oil shale lease stipulations and to formulate the required fish and wildlife plan and procedures for mitigating potential damage to the aquatic habitat. The studies will attempt to ascertain the correlations between present water quality and existing aquatic species. In addition, the study will also determine whether there are any rare or endangered species of fish in the streams around the tract area.

Topics covered in this first quarterly report include fish, benthos, periphyton, and water quality. Water samples for the study of plankton have been collected and laboratory identification is awaited. The study of primary productivity will be commenced in the spring of 1975.

SCOPE OF STUDY

Monthly collections of aquatic organisms from various stations were begun in August 1974. Sample collection dates will be provided in the next quarterly report. The location and description of each sample station are given below. The sample stations in the vicinity of Tract C-b are shown on Figure II-1. In addition, there are two stations located on the White River.

Station P-1: Piceance Creek, about 1 mile upstream from Stewart Gulch Road. Substrate consists of mud, compacted clay, and small rubble. Located approximately 1 mile outside of Tract C-b boundary.



NOTE:

Piceance Creek sites (P-1 thru P-7)
Willow Creek sites (W-1 thru W-3)
Stewart Creek sites (S-1, S-2)
- - - = Roads

Figure II-1. AQUATIC STUDY AREAS

Station P-2: Piceance Creek, at the Walter Oldland Ranch, below the confluence of Stewart Creek. Substrate consists of mud and compacted clay. Corresponds roughly to Station 1 of May (1970).

Station P-3: Piceance Creek, below Sorghum Gulch drainage. Substrate consists of small to medium rubble with some mud and clay. There is a small waterfall at the upper end of the station. Corresponds roughly to Station IV of Everhart and May (1973).

Station P-4: Piceance Creek, below the Redd Ranch, near the meteorology station. Substrate consists of small rubble and mud.

Station P-5: Piceance Creek, approximately 1 mile above the confluence of Willow Creek and Piceance Creek. The substrate consists of small flat rubble, mud, and compacted clay. At the upper end of the station is a waterfall approximately 10 feet high. There is a deep pool beneath the waterfall.

Station P-6: Piceance Creek, approximately 1 mile below the confluence with Willow Creek, where the Hunter Creek Road crosses the stream. Substrate consists of mud, compacted clay, and some gravel.

Station P-7: Piceance Creek, 7.8 miles downstream from P-6 along the Piceance Creek Road (Section 21, R97W, T1S). Substrate consists of mud and compacted clay.

Station WR-1: White River, approximately 1 mile above the confluence of Piceance Creek with the White River. Substrate consists of small to large rubble, boulders, and sandy silt in the interstices.

Station WR-2: White River, approximately 1 mile below the confluence of Piceance Creek and the White River. Substrate consists of small to large rubble and sandy silt. It corresponds roughly with Station 4 of Pethis (1974).

Station W-1: Willow Creek, approximately 1 mile upstream from the boundary of Tract C-b. Substrate consists of small, well-embedded rubble. The stream is spring-fed.

Station W-2: Willow Creek, below the confluence of the drainage from Scandard Gulch, just outside the tract boundary. The substrate consists of sandy silt and gravel.

Station W-3: Willow Creek, just above the confluence of Willow Creek and Piceance Creek. Substrate consists of gravel and sandy silt.

Station WL-1: Upper Willow Lake, approximately 1 mile downstream from Station W-1. Upper Willow Lake is a shallow, spring-fed, man-made impoundment of about a half-acre. It has a sandy and muck bottom that is rich in organic detritus.

Station WL-2: Lower Willow Lake, approximately 1 mile north of Upper Willow Lake, is a small (0.1 acre) spring pond about 10 feet deep. It has a sandy and mucky bottom that is rich in organic detritus.

Station S-1: Stewart Creek, approximately 1 mile up Stewart Gulch from the Walter Oldland Ranch, where the road to the West Fork of Stewart Gulch crosses Stewart Creek. Substrate consists of small embedded rubble and some sandy silt.

Station S-2: Stewart Creek, just upstream from the confluence of Stewart Creek and Piceance Creek. Substrate consists of sandy silt and gravel.

Station SL-1: Upper Stewart Lake, in Middle Fork of Stewart Creek Gulch. The lake is a spring-fed, man-made impoundment of approximately 2 acres. The substrate is mud and silt and is rich in organic detritus.

Station SL-2: Lower Stewart Lake, located about a quarter-mile south of Piceance Creek Road along the Stewart Gulch Road. Lower Stewart Lake is a spring-fed, man-made impoundment about an acre in size. The substrate consists of small flat rubble and silt that is rich in organic detritus. There is a constant flow through the lake into a 12-inch culvert, which in turn empties into a channel. The channel flows into Stewart Creek approximately 200 yards above the confluence of Stewart Creek and Piceance Creek. The substrate in the channel is similar to that of the lake.

LITERATURE REVIEW

Published literature contains very little information about the biology and related chemical and physical factors in streams of the Piceance Basin. May (1970) and Everhart and May (1973) discuss the chemistry and biota of Piceance Creek and the White River. Pennak's limnological study (1974) of streams in the Piceance Basin includes information on physical and chemical factors, bottom fauna, and periphyton. Pethis (1974) collected fishes from a number of streams in the Piceance Basin area. Several of these studies had sampling stations similar to those in this investigation and will be useful for comparison with the present baseline study.

METHODOLOGY

Fish

A variable-voltage, DC battery-operated backpack shocker is used to collect fish from the streams in the site area on a bimonthly basis. In the lakes and ponds, two 0.5-inch-mesh nylon seines are used to collect fish. These seines are 6 by 100 feet and 6 by 50 feet in size.

In order to obtain quantitative data on fish populations in the streams, a 100-meter stretch of stream is fished with the backpack shocker. After removal from the stream, fish are kept in a live-box until they are weighed, measured, marked, and returned to the stream.

To detect any migration of game fish as stipulated in the oil shale lease, captured fish will be marked and released alive. The recapture of any of these marked individuals in later samples will provide necessary information on migratory patterns.

Benthos

Benthic invertebrates are sampled monthly with a standard square-foot Surber sampler. Three random samples are taken at each station and preserved in ethanol. Identification is carried to the genus level.

Periphyton

Perphyton (attached plants and microinvertebrates) are collected monthly by removing six glass slides (3 x 5 inches) from a holder which has been immersed in the stream at most stations for about a month. Three of the six slides are preserved in vials of formalin for qualitative analysis. The other three slides are air-dried and stored for quantitative analysis.

Water Quality

Water samples are collected monthly at each station on the tract. The samples are taken on the same day that the USGS collects water samples from the same area. Measurements of dissolved oxygen, pH, temperature, and specific conductivity are made in the field at the time of collection. Water samples for further analysis are placed in 1-quart plastic containers and put on ice until time of analysis. Analyses in the laboratory conform to those specified in APHA Standard Methods (1973) and EPA Publication 16020-07/71.

Plankton and Primary Productivity

Plankton and primary productivity data have not been compiled to date. The methods used for the accumulation of these data will be presented in the next quarterly report.

RESULTS AND DISCUSSION

Fish

Fish were collected during September and November as part of the aquatic baseline studies. The turbid nature of Piceance Creek made sampling difficult, especially in November. So far, three species of game fish and four species of rough fish have been collected from the waters draining Tract C-b and from the White River (Table II-1).

When the numbers of the fish species are compared (Table II-2), it is evident that the mountain sucker (Catostomus platyrhynchus) is by far the most abundant species. The brook trout were second highest in abundance, but the population is concentrated in Lower Stewart Lake and in the channel that drains the lake.

At the present time, there is insufficient data to draw conclusions about the fish populations of Piceance Creek or the White River. Only the mountain sucker (Catostomus platyrhynchus) has been collected in sufficient numbers to allow a detailed examination of the population structure. It is interesting to note the difference in numbers of fish captured at various stations on Piceance Creek. The greatest numbers of fish occurred at Stations P-1 and P-3 (Table II-2). Both of these stations have a rocky substrate and seem to offer better habitat for fish than do other stations along Piceance Creek. There also seems to be a general trend for numbers of fish to increase in an upstream direction. Further collections of fish from Piceance Creek will help to substantiate whether or not there are true differences in fish populations at the various stations. The random distribution of game fish captured thus far would seem to indicate that these fish are scattered and occupy suitable habitats where they exist along Piceance Creek. This is similar to the situation in May 1974, when several trout were found throughout the length of Piceance Creek (Woodward-Envicon, 1974). Marking the fish

Table II-1. LIST OF SPECIES OF FISH CAPTURED DURING SEPTEMBER AND NOVEMBER 1974

Scientific Name	Common Name
Salmo gairdneri	Rainbow trout
Salmo trutta	Brown trout
Salvelinus fontinalis	Brook trout
Rhinichthys osculus	Speckled dace
Catostomus latipinnus	Flannelmouth sucker
Catostomus platyrhynchus	Mountain sucker
Cottus bairdi	Mottled sculpin

Table II-2. NUMERICAL ABUNDANCE OF SPECIES OF FISH CAPTURED DURING SEPTEMBER AND NOVEMBER 1974

	SPECIES							
STATION	Rainbow Trout	Brown Trout	Brook Trout	Flannel-mouth Sucker	Mountain Sucker	Speckled Dace	Mottled Sculpin	Total Number
P-1		1	1		148	30		180
P-2					38			38
P-3					50	2		52
P-4					3	2		5
P-5	2				20			22
P-6					18	6		24
P-7					2			2
WR-1				1			2	3
WR-2							6	6
W-1								
W-2								
W-3			3		2	1		6
WL-1								
WL-2								
S-1								
S-2								
SL-1								
SL-2			93					93

captured should make it possible to determine whether or not the game fish are resident or are migrating through the area. Collections in future months should provide needed information on fish migration.

Benthos

Benthic invertebrates (bottom-dwelling organisms) were collected from seven sites on Piceance Creek (P-1 through P-7), four sites on Stewart Creek (S-1, S-2, SL-1, SL-2), five sites on Willow Creek (W-1 through W-3, WL-1, WL-2), and two sites on the White River (WR-1, WR-2). The numbers and species composition of aquatic fauna collected are presented in Tables II-3 through II-36. Because of incomplete (but continuing) sample analysis, conclusions cannot yet be drawn regarding biomass (volumetric values) and species diversity. A list of the benthic fauna collected from representative watercourses is shown in Table II-36.

Notable at this time is the rich production of more desirable fish food species (mayflies, damselflies, dragonflies, etc.) within upper Stewart and Willow lakes (Tables II-13, II-19, II-23, and II-29). The absence of fish populations within these lakes allows these more desirable species to increase unchecked. Also noteworthy is that the lowermost stations of Piceance Creek (P-6 and P-7) have by far the poorest benthic species composition. This is mainly due to the mud and compact clay substratum in these areas, which provide no points of attachment for benthic fauna.

Pennak (1974) states that during the months of August and September many of the desirable fish food species such as mayflies, caddisflies, and stoneflies have either emerged as adult flying insects or are present in immature stages. Thus low populations of these species at many sites during the late summer and fall sampling period may provide false interpretations of the benthic fauna in the aquatic systems.

(text continues on page II-47)

Table II-3. DIPTERA. NUMERICAL ABUNDANCE AND TAXONOMIC COMPOSITION OF BENTHIC FAUNA TAKEN FROM PICEANCE CREEK DURING SEPTEMBER AND OCTOBER, 1974

Taxa	Station																					Total Number of Individuals
	P-1			P-2			P-3			P-4			P-5			P-6			P-7			
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	
SEPTEMBER																						
Chironomus	21	18	16	6	5	4		22	24	1	15	2	12	4		2		2		1		157
Simulium		4	1		1	6		16	18	4	8	26	15	4								103
Limnophora										5		5										10
Odontomyia												1										1
Dixa																						0
Tipulidae					1	1				1							1					4
Tabanidae																						0
																					TOTAL	275
OCTOBER																						
Chironomus	11	5	6			3	9	6	5	2				3	2				2	8	3	65
Simulium	1	9	9			27	14	48	5	2		8			20							143
Limnophora				1			1	1							1							4
Odontomyia																						0
Dixa																						0
Tipulidae															2			1				3
Tibanidae																						0
																					TOTAL	215

Table II-4. COLEOPTERA. NUMERICAL ABUNDANCE AND TAXONOMIC COMPOSITION OF BENTHIC FAUNA TAKEN FROM PICEANCE CREEK DURING SEPTEMBER AND OCTOBER, 1974

Taxa	Station																					Total Number of Individuals
	P-1			P-2			P-3			P-4			P-5			P-6			P-7			
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	
SEPTEMBER																						
Agabinus																						0
Haliplus																						0
Hydrophilinae																						0
Gyrinus	1																					1
Helichus													1									1
Ancyronyx	1							1					2	3								7
																				TOTAL		9
OCTOBER																						
Agabinus																						0
Haliplus										1												1
Hydrophilinae																						0
Gyrinus																						0
Helichus																						0
Ancyronyx													3									3
																				TOTAL		4

Table II-5. EPHEMEROPTERA. NUMERICAL ABUNDANCE AND TAXONOMIC COMPOSITION OF BENTHIC FAUNA TAKEN FROM PICEANCE CREEK DURING SEPTEMBER AND OCTOBER, 1974

Taxa	Station																					Total Number of Individuals
	P-1			P-2			P-3			P-4			P-5			P-6			P-7			
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	
SEPTEMBER																						
Baetis	3	9		42	24	26		22	62	9	37	12	40	10	4	3	18	14				335
Iron	2							12						12								26
																					TOTAL	361
OCTOBER																						
Baetis							8	13	8	4		5		3	6	3	3					53
Iron	22	17	33	12		7	63	44	14	18	32	29	16	14	21			15		1		358
																					TOTAL	411

Table II-6. PLECOPTERA. NUMERICAL ABUNDANCE AND TAXONOMIC COMPOSITION OF BENTHIC FAUNA TAKEN FROM PICEANCE CREEK DURING SEPTEMBER AND OCTOBER, 1974

Taxa	Station																		Total Number of Individuals
	P-1			P-2			P-3			P-4			P-5			P-6			P-7			
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	
SEPTEMBER																						
																						0
Isoperla											1											1
Isogenus																						
																					TOTAL	1
OCTOBER																						
																						8
Isoperla	3						1	1	1				2									0
Isogenus																						
																					TOTAL	8

Table II-7. TRICHOPTERA. NUMERICAL ABUNDANCE AND TAXONOMIC COMPOSITION OF BENTHIC FAUNA TAKEN FROM PICEANCE CREEK DURING SEPTEMBER AND OCTOBER, 1974

Taxa	Station																		Total Number of Individuals
	P-1			P-2			P-3			P-4			P-5			P-6			P-7			
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	
SEPTEMBER																						
Hydropsyche					3						2	7	17	26	5	1						61
Molanna													1									1
Brachycentrus																						0
																					TOTAL	62
OCTOBER																						
Hydropsyche							6	4	6	2	2	1	6	2								29
Molanna																						0
Brachycentrus																						0
																					TOTAL	29

Table II-8. MOLLUSCA. NUMERICAL ABUNDANCE AND TAXONOMIC COMPOSITION OF BENTHIC FAUNA TAKEN FROM PICEANCE CREEK DURING SEPTEMBER AND OCTOBER, 1974

Taxa	Station																					Total Number of Individuals
	P-1			P-2			P-3			P-4			P-5			P-6			P-7			
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	
SEPTEMBER																						
Sphaeridae																						0
Physidae					1																	1
Lymnaeidae													1				1					2
																					TOTAL	3
OCTOBER																						
Sphaeridae																						0
Physidae																						0
Lymnaeidae																						0
																					TOTAL	0

Table II-9. AMPHIPODA. NUMERICAL ABUNDANCE AND TAXONOMIC COMPOSITION OF BENTHIC FAUNA TAKEN FROM PICEANCE CREEK DURING SEPTEMBER AND OCTOBER, 1974

Taxa	Station																					Total Number of Individuals
	P-1			P-2			P-3			P-4			P-5			P-6			P-7			
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	
SEPTEMBER																						
Gammarus								1						1	1							3
																					TOTAL	3
OCTOBER																						
Gammarus															2							2
																					TOTAL	2

Table II-10. OLIGOCHAETA, HIRUDINEA, HOMOPTERA, HYDRACARINA. NUMERICAL ABUNDANCE AND TAXONOMIC COMPOSITION OF BENTHIC FAUNA TAKEN FROM PICEANCE CREEK DURING SEPTEMBER AND OCTOBER, 1974

Taxa	Station																					Total Number of Individuals
	P-1			P-2			P-3			P-4			P-5			P-6			P-7			
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	
SEPTEMBER																						
Oligochaeta		3		6	4			14		1		3	2		17	11	8	26		12	19	125
Hirudinea	1				1					6			5									13
Hydracarina													4	1								5
Aphididae	1													1								2
																					TOTAL	145
OCTOBER																						
Oligochaeta					3			1				1		1		1			9			16
Hirudinea	1									1					1		2					5
Hydracarina																						0
Aphididae																						0
																					TOTAL	21

Table II-11. DIPTERA. NUMERICAL ABUNDANCE AND TAXONOMIC COMPOSITION OF BENTHIC FAUNA TAKEN FROM STEWART CREEK AND LAKES DURING SEPTEMBER AND OCTOBER, 1974

Taxa	Station												Total Number of Individuals
	S-1			S-2			SL-1			SL-2			
	A	B	C	A	B	C	A	B	C	A	B	C	
SEPTEMBER													
Chironomus	2	2	1	25	25	64	57	2	7	104	287	373	949
Simulium				88		160							248
Limnophora													0
Odontomyia				3				1					4
Dixa								7	12				19
Tipulidae			3		1								4
Tabanidae													0
												TOTAL	1,224
OCTOBER													
Chironomus	16	11	8	2	3	4	144			34			222
Simulium				4	1	22							27
Limnophora	3		2	1		1							7
Odontomyia		1											1
Dixa													0
Tipulidae	4	1	1										6
Tabanidae													0
												TOTAL	263

Table II-12. COLEOPTERA. NUMERICAL ABUNDANCE AND TAXONOMIC COMPOSITION OF BENTHIC FAUNA TAKEN FROM STEWART CREEK AND LAKES DURING SEPTEMBER AND OCTOBER, 1974

Taxa	Station												Total Number of Individuals
	S-1			S-2			SL-1			SL-2			
	A	B	C	A	B	C	A	B	C	A	B	C	
SEPTEMBER													
Agabinus						1	1						2
Haliplus													0
Hydrophilinae					2	4	1					2	9
Gyrinus													0
Helichus													0
Ancyronyx													0
												TOTAL	11
OCTOBER													
Agabinus						1	1						2
Haliplus													0
Hydrophilinae													0
Gyrinus													0
Helichus													0
Ancyronyx													0
												TOTAL	2

Table II-13. EPHEMEROPTERA. NUMERICAL ABUNDANCE AND TAXONOMIC COMPOSITION OF BENTHIC FAUNA TAKEN FROM STEWART CREEK AND LAKES DURING SEPTEMBER AND OCTOBER, 1974

Taxa	Station												Total Number of Individuals
	S-1			S-2			SL-1			SL-2			
	A	B	C	A	B	C	A	B	C	A	B	C	
SEPTEMBER													
Baetis	3	19	3	13	6	24		101	43		9	1	222
Iron													0
												TOTAL	222
OCTOBER													
Baetis	8	5					1600			8			1,619
Iron		2											2
												TOTAL	1,621

Table II-14. PLECOPTERA. NUMERICAL ABUNDANCE AND TAXONOMIC COMPOSITION OF BENTHIC FAUNA TAKEN FROM STEWART CREEK AND LAKES DURING SEPTEMBER AND OCTOBER, 1974

Taxa	Station												Total Number of Individuals
	S-1			S-2			SL-1			SL-2			
	A	B	C	A	B	C	A	B	C	A	B	C	
SEPTEMBER													
Isoperla	4	2	2										8
Isogenus													0
												TOTAL	8
OCTOBER													
Isoperla	5	5	1										11
Isogenus													0
												TOTAL	11

Table II-15. TRICHOPTERA. NUMERICAL ABUNDANCE AND TAXONOMIC COMPOSITION OF BENTHIC FAUNA TAKEN FROM STEWART CREEK AND LAKES DURING SEPTEMBER AND OCTOBER, 1974

Taxa	Station												Total Number of Individuals
	S-1			S-2			SL-1			SL-2			
	A	B	C	A	B	C	A	B	C	A	B	C	
SEPTEMBER													
Hydropsyche		1			2						7		10
Molanna													0
Brachycetrus													0
												TOTAL	10
OCTOBER													
Hydropsyche													0
Malanna		2			2								4
Brachycentrus													0
												TOTAL	4

Table II-16. MOLLUSCA. NUMERICAL ABUNDANCE AND TAXONOMIC COMPOSITION OF BENTHIC FAUNA TAKEN FROM STEWART CREEK AND LAKES DURING SEPTEMBER AND OCTOBER, 1974

Taxa	Station												Total Number of Individuals
	S-1			S-2			SL-1			SL-2			
	A	B	C	A	B	C	A	B	C	A	B	C	
SEPTEMBER													
Sphaeridae													0
Physidae										1			1
Lymnaeidae													0
												TOTAL	1
OCTOBER													
Sphaeridae													0
Physidae				10		2	24						36
Lymnaeidae										2			2
												TOTAL	38

Table II-17. AMPHIPODA. NUMERICAL ABUNDANCE AND TAXONOMIC COMPOSITION OF BENTHIC FAUNA TAKEN FROM STEWART CREEK AND LAKES DURING SEPTEMBER AND OCTOBER, 1974

Taxa	Station												Total Number of Individuals
	S-1			S-2			SL-1			SL-2			
	A	B	C	A	B	C	A	B	C	A	B	C	
SEPTEMBER													
Gammarus				51	4	9				10	2		76
												TOTAL	76
OCTOBER													
Gammarus			2	66		7	8			2			85
												TOTAL	85

Table II-18. OLIGOCHAETA, HIRUDINEA, HOMOPTERA, HYDRACARINA — NUMERICAL ABUNDANCE AND TAXONOMIC COMPOSITION OF BENTHIC FAUNA TAKEN FROM STEWART CREEK AND LAKES DURING SEPTEMBER AND OCTOBER, 1974

Taxa	Station												Total Number of Individuals
	S-1			S-2			SL-1			SL-2			
	A	B	C	A	B	C	A	B	C	A	B	C	
SEPTEMBER													
Oligochaeta										2			2
Hirudinea				5	1	8							14
Hydracarina													0
Aphididae													0
												TOTAL	16
OCTOBER													
Oligochaeta													0
Hirudinea				16		6							22
Hydracarina													0
Aphididae		1											1
												TOTAL	23

Table II-19. ODONATA. NUMERICAL ABUNDANCE AND TAXONOMIC COMPOSITION OF BENTHIC FAUNA TAKEN FROM STEWART CREEK AND LAKES DURING SEPTEMBER AND OCTOBER, 1974

Taxa	Station												Total Number of Individuals
	S-1			S-2			SL-1			SL-2			
	A	B	C	A	B	C	A	B	C	A	B	C	
SEPTEMBER													
Ischnura								64	84				148
Gomphus								5	2				7
												TOTAL	155
OCTOBER													
Ischnura							5						5
Gomphus													0
												TOTAL	5

Table II-20. HEMIPTERA. NUMERICAL ABUNDANCE AND TAXONOMIC COMPOSITION OF BENTHIC FAUNA TAKEN FROM STEWART CREEK AND LAKES AND DURING SEPTEMBER AND OCTOBER, 1974

Taxa	Station												Total Number of Individuals
	S-1			S-2			SL-1			SL-2			
	A	B	C	A	B	C	A	B	C	A	B	C	
SEPTEMBER													
*Corixinae											1		1
Notonecta								3					3
												TOTAL	4
OCTOBER													
*Corixinae							3			3			6
Notonecta													0
												TOTAL	6

* The genus Corixinae comprises only males

Table II-21. DIPTERA. NUMERICAL ABUNDANCE AND TAXONOMIC COMPOSITION OF BENTHIC FAUNA TAKEN FROM WILLOW CREEK AND LAKES DURING SEPTEMBER AND OCTOBER, 1974

Taxa	Station															Total Number of Individuals
	W-1			W-2			W-3			WL-1			WL-2 *			
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	
SEPTEMBER																
Chironomus	36	60	34	7	2		1	1	1	362	73	59				636
Simulium	18	28	42	7	42	21		1	1							160
Limnophora	9	4	19	5	9	5		2								53
Odontomyia	4	6	6	6	1	4										27
Dixa																0
Tipulidae		1	1	21	7	7		3	1							41
Tabanidae																0
															TOTAL	917
OCTOBER																
Chironomus	11	2	4	2	11	3	8	26		5						72
Simulium	28	4	7	5	23	3										70
Limnophora	12	11	11			2	2	1	3							42
Odontomyia	8		23		1											32
Dixa																0
Tipulidae			4	5	14	3	3	9	4							42
Tabanidae																0
															TOTAL	258

* Samples were unidentifiable

Table II-22. COLEOPTERA. NUMERICAL ABUNDANCE AND TAXONOMIC COMPOSITION OF BENTHIC FAUNA TAKEN FROM WILLOW CREEK AND LAKES DURING SEPTEMBER AND OCTOBER, 1974

Taxa	Station															Total Number of Individuals
	W-1			W-2			W-3			WL-1			WL-2 *			
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	
SEPTEMBER																
Agabinus						2					4					6
Haliplus			2													2
Hydrophilinae									1							1
Gyrinus																0
Helichus																0
Ancyronyx																0
															TOTAL	9
OCTOBER																
Agabinus										1						1
Haliplus																0
Hydrophilinae							1									1
Gyrinus																0
Helichus																0
Ancyronyx																0
															TOTAL	2

* Samples were unidentifiable

Table II-23. EPHEMEROPTERA. NUMERICAL ABUNDANCE AND TAXONOMIC COMPOSITION OF BENTHIC FAUNA TAKEN FROM WILLOW CREEK AND LAKES DURING SEPTEMBER AND OCTOBER, 1974

Taxa	Station															Total Number of Individuals
	W-1			W-2			W-3			WL-1			WL-2 *			
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	
SEPTEMBER																
Baetis		4	5	8	8	8	67	14	37	98	37	83				218
Iron																0
															TOTAL	218
OCTOBER																
Baetis					6		5	3								14
Iron										81						81
															TOTAL	95

* Samples were unidentifiable

Table II-24. PLECOPTERA. NUMERICAL ABUNDANCE AND TAXONOMIC COMPOSITION OF BENTHIC FAUNA TAKEN FROM WILLOW CREEK AND LAKES DURING SEPTEMBER AND OCTOBER, 1974

Taxa	Station															Total Number of Individuals
	W-1			W-2			W-3			WL-1			WL-2 *			
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	
SEPTEMBER																
Isoperla						2										2
Isogenus																0
															TOTAL	2
OCTOBER																
Isoperla					2	2										4
Isogenus																0
															TOTAL	4

* Samples were unidentifiable

Table II-25. TRICHOPTERA. NUMERICAL ABUNDANCE AND TAXONOMIC COMPOSITION OF BENTHIC FAUNA TAKEN FROM WILLOW CREEK AND LAKES DURING SEPTEMBER AND OCTOBER, 1974

Taxa	Station															Total Number of Individuals
	W-1			W-2			W-3			WL-1			WL-2*			
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	
SEPTEMBER																
Hydropsyche	1			6	4	7			1							19
Malanna																0
Brachycetrus																0
															TOTAL	19
OCTOBER																
Hydropsyche					1											1
Malanna																0
Brachycetrus																0
															TOTAL	1

* Samples were unidentifiable

Table II-26. MOLLUSCA. NUMERICAL ABUNDANCE AND TAXONOMIC COMPOSITION OF BENTHIC FAUNA TAKEN FROM WILLOW CREEK AND LAKES DURING SEPTEMBER AND OCTOBER, 1974

Taxa	Station															Total Number of Individuals
	W-1			W-2			W-3			WL-1			WL-2 *			
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	
SEPTEMBER																
Sphaeridae				10	5											15
Physidae				43	4											47
Lymnaeidae			2			4				1	16	4				27
															TOTAL	89
OCTOBER																
Sphaeridae																0
Physidae																0
Lymnaeidae	3															3
															TOTAL	3

* Samples were unidentifiable

Table II-27. AMPHIPODA. NUMERICAL ABUNDANCE AND TAXONOMIC COMPOSITION OF BENTHIC FAUNA TAKEN FROM WILLOW CREEK AND LAKES DURING SEPTEMBER AND OCTOBER, 1974

Taxa	Station															Total Number of Individuals
	W-1			W-2			W-3			WL-1			WL-2 *			
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	
SEPTEMBER																
Gammarus				4	3	4			2		4	8				25
															TOTAL	25
OCTOBER																
Gammarus					1											1
															TOTAL	1

* Samples were unidentifiable

Table II-28. OLIGOCHAETA, HIRUDINEA, HOMOPTERA, HYDRACARINA. NUMERICAL ABUNDANCE AND TAXONOMIC COMPOSITION OF BENTHIC FAUNA TAKEN FROM WILLOW CREEK AND LAKES DURING SEPTEMBER AND OCTOBER, 1974

Taxa	Station															Total Number of Individuals
	W-1			W-2			W-3			WL-1			WL-2 *			
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	
SEPTEMBER																
Oligochaeta							3	4	3							10
Hirudinea								1	1							2
Hydracarina							1									0
Aphididae																1
															TOTAL	13
OCTOBER																
Oligochaeta								21	64							85
Hirudinea																0
Hydracarina																0
Aphididae																0
															TOTAL	85

* Samples were unidentifiable

Table II-29. ODONATA. NUMERICAL ABUNDANCE AND TAXONOMIC COMPOSITION OF BENTHIC FAUNA TAKEN FROM WILLOW CREEK AND LAKES DURING SEPTEMBER AND OCTOBER, 1974

Taxa	Station															Total Number of Individuals
	W-1			W-2			W-3			WL-1			WL-2*			
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	
SEPTEMBER																
Ischnura											11	7				18
Gomphus																0
															TOTAL	18
OCTOBER																
Ischnura										24						24
Gomphus										1						1
															TOTAL	25

* Samples were unidentifiable

Table II-30. HEMIPTERA. NUMERICAL ABUNDANCE AND TAXONOMIC COMPOSITION OF BENTHIC FAUNA TAKEN FROM WILLOW CREEK AND LAKES DURING SEPTEMBER AND OCTOBER, 1974

Taxa	Station															Total Number of Individuals
	W-1			W-2			W-3			WL-1			WL-2 *			
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	
SEPTEMBER																
**Corixinae										1						1
Notonecta											2					2
															TOTAL	3
OCTOBER																
*Corixinae																0
Notonecta										5						5
															TOTAL	5

* Samples were unidentifiable

** The genus Corixinae comprises only males

Table II-31. DIPTERA. NUMERICAL ABUNDANCE AND TAXONOMIC COMPOSITION OF BENTHIC FAUNA TAKEN FROM THE WHITE RIVER DURING SEPTEMBER AND OCTOBER, 1974

Taxa	Station						Total Number of Individuals
	WR-1			WR-2			
	A	B	C	A	B	C	
SEPTEMBER							
Chironomus	9	5	19	2	7	4	46
Simulium	1			2	41		44
Limnophora					3		3
Odontomyia							0
Dixa							0
Tipulidae			2	2	4	14	22
Tabanidae					1		1
						TOTAL	113
OCTOBER							
Chironomus	3	9	6	12	23	15	68
Simulium		1					1
Limnophora							0
Odontomyia							0
Dixa							0
Tipulidae				1	1		2
Tabanidae							0
						TOTAL	71

Table II-32. EPHEMEROPTERA. NUMERICAL ABUNDANCE AND TAXONOMIC COMPOSITION OF BENTHIC FAUNA TAKEN FROM THE WHITE RIVER DURING SEPTEMBER AND OCTOBER, 1974

Taxa	Station						Total Number of Individuals
	WR-1			WR-2			
	A	B	C	A	B	C	
SEPTEMBER							
Baetis	44	11	32	14	173	76	350
Iron	3	4			1		8
						TOTAL	358
OCTOBER							
Baetis					1		1
Iron			7	8	5		20
						TOTAL	21

Table II-33. PLECOPTERA. NUMERICAL ABUNDANCE AND TAXONOMIC COMPOSITION OF BENTHIC FAUNA TAKEN FROM THE WHITE RIVER DURING SEPTEMBER AND OCTOBER, 1974

Taxa	Station						Total Number of Individuals
	WR-1			WR-2			
	A	B	C	A	B	C	
SEPTEMBER							
Isoperla					1		1
Isogenus				1			1
						TOTAL	2
OCTOBER							
Isoperla	14	4	12	6	2	2	40
Isogenus							0
						TOTAL	40

Table II-34. TRICHOPTERA. NUMERICAL ABUNDANCE AND TAXONOMIC COMPOSITION OF BENTHIC FAUNA TAKEN FROM THE WHITE RIVER DURING SEPTEMBER AND OCTOBER, 1974

Taxa	Station						
	WR-1			WR-2			
	A	B	C	A	B	C	of Individuals
SEPTEMBER							
Hydropsyche	31	50	1	19	97	12	210
Molanna							0
Brachycentrus					1		1
						TOTAL	211
OCTOBER							
Hydropsyche				11		4	15
Molanna							0
Brachycentrus							0
						TOTAL	15

Table II-35. HEMIPTERA. NUMERICAL ABUNDANCE AND TAXONOMIC COMPOSITION OF BENTHIC FAUNA TAKEN FROM THE WHITE RIVER DURING SEPTEMBER AND OCTOBER, 1974

Taxa	Station						Total Number of Individuals
	WR-1			WR-2			
	A	B	C	A	B	C	
SEPTEMBER							
*Corixidae				3			3
Corixinae							0
Notonecta							0
						TOTAL	3
OCTOBER							
*Corixidae	1						1
Corixinae		1					1
Notonecta							0
						TOTAL	2

* Females of this family cannot be taken to genus level of classification. The genus Corixinae comprises only males.

Table II-36. COMMON AND TAXONOMIC NAMES OF BENTHIC INVERTEBRATES COLLECTED FROM PICEANCE CREEK, WILLOW CREEK, STEWART CREEK, AND THE WHITE RIVER DURING SEPTEMBER AND OCTOBER, 1974

COMMON NAME	TAXA
	Phylum ARTHROPODA
	Class Insecta
Beetles	Order Coleoptera
	Family Dytiscidae
	Genus *Agabinus*
	Haliplidae
	Haliplus
	Hydrophilidae
	Hydrophilinae
	Gyrinidae
	Gyrinus
	Dryopidae
	Helichus
	Elmidae
	Ancyronyx
True flies	Diptera
	Chironomidae
	Chironomus
	Simuliidae
	Simulium
	Anthomyiidae
	Limnophora
	Stratiomyidae
	Odontomyia
	Dixidae
	Dixa
	Tipulidae
	Tabanidae
Mayflies	Ephemeroptera
	Baetidae
	Baetis
	Heptageniidae
	Iron
True bugs	Hemiptera
	Corixidae
	Corixinae

Table II-36. (Continued)

COMMON NAME	TAXA
	Notonectidae
	Notonecta
Aphids	Homoptera
	Aphididae
Damselflies & Dragonflies	Odonata
	Coenagrionidae
	Ischnura
	Gomphidae
	Gomphus
Stoneflies	Plecoptera
	Perlodidae
	Isoperla
	Isogenus
Caddisflies	Trichoptera
	Hydropsychidae
	Hydropsyche
	Molannidae
	Molanna
	Brachycentridae
	Brachycentrus
	Crustacea
Scuds	Amphipoda
	Gammaridae
	Gammarus
Water mites	Hydracarina
	MOLLUSCA
Clams	Pelecypoda
	Sphaeridae
Snails	Gastropoda
	Physidae
	Lymnaeidae

Table II-36. (Concluded)

COMMON NAME	TAXA
	ANNELIDA
Aquatic Earthworms	Oligochaeta
Leeches	Hirudinea

Periphyton

Periphyton is the assemblage of microscopic plants and invertebrates that covers the stream substrate. At this time the analysis of periphyton collected from the glass slides immersed in the water at various locations is incomplete. Table II-37 lists genera of algae and rooted plants which have been identified to date. It should be noted that diatoms are by far the most abundant form of periphyton. Since sample analysis is incomplete, it is not possible to draw any conclusions as to the significance of abundance, biomass, or distribution of the organisms identified to date.

Water Quality

Water quality analyses performed in the laboratory included measurements of those cations and anions which were indicators of water hardness, organic and inorganic cations and anions, and bacteria and pathogen cultures (Tables II-38 through II-45). Additional analyses performed in the field included measurements of dissolved oxygen, pH, temperature, and specific conductance (Tables II-38 through II-45).

Notable at this time is the consistent increase in calcium, magnesium, sodium, sulfate, and bicarbonate from August to October. This may be partially explained by the considerable drop in flow levels from August to October. Another notable change is the fecal coliform count. The increase and decrease in these coliform levels closely coincides with the presence and absence of grazing cattle on the meadows along Piceance Creek.

Periphyton and Primary Productivity

Periphyton and primary productivity data have not been sufficiently analyzed for inclusion in this report. Results and discussion of these portions of the aquatic study will be in the next quarterly report.

Table II-37. LIST OF GENERA* OF PERIPHYTON COLLECTED FROM PICEANCE CREEK, WILLOW CREEK, STEWART CREEK, AND THE WHITE RIVER DURING SEPTEMBER 1974

Scientific Name	Common Name
Chlorophyceae	Green algae
Pediastrum	
Spirogyra	
Ulothrix	
Microspora	
Protococcus	
Cladophora	
Vaucheria	
Bacillariophyceae	Diatoms
Melasira	
Cyclotella	
Meridion	
Diatoma	
Asterionella	
Fragilaria	
Synedia	
Eunotia	
Cocconeis	
Caloneis	
Diploneis	
Frustulia	
Gyrosigma	
Navicula	
Pinnularia	
Gomphonema	

Table II-37 (concluded)

Cymbella	
Amphora	
Nitzschia	
Sirurella	
Cyanophyta	Blue-green algae
Agmenellum	
Lyngbya	
Phormidium	
Tracheophyta	Vascular plants
Najas	
Ranunculus	
Potamogeton	Pondweed
Mimulus	Figwort
Nasturtium	Watercress

*Identifications after H. B. Ward and G. C. Whipple, 1965, *Freshwater Biology*. 2nd edition, edited by W. T. Edmonson. New York: John Wiley and Sons.

Table II-38. MINERAL AND NUTRIENT CONTENT (in mg/l) OF PICEANCE CREEK STATIONS, TAKEN IN AUGUST, SEPTEMBER, AND OCTOBER 1974

	Cations					Anions					
	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Ammonia (NH_4)	Hydroxide (OH)	Carbonate (CO_3)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)
STATION P-1											
August	22	50	120	2.8	0.89	0	24	342	166	25	1.4
September	66	35	138	1.9	0	0	12	476	155	17	0.35
October	52	49	140	3.1	0	0	6	512	165	20	0.13
STATION P-2											
August	20	46	136	2.9	0	0	24	329	163	25	1.6
September	67	50	144	2.0	0	0	12	476	222	19	1.3
October	70	60	144	2.5	0.09	0	6	500	262	20	2.1
STATION P-3											
August	22	46	136	2.9	0	0	36	323	186	20	2.0
September	44	56	141	2.0	0	0	12	427	232	19	1.7
October	68	63	144	2.3	0	0	12	500	277	20	1.2
STATION P-4											
August	28	49	136	3.1	0	0	30	342	193	25	1.5
September	52	53	144	1.9	0	0	12	421	236	15	1.8
October	68	63	156	2.7	0	0	18	488	287	20	1.2
STATION P-5											
August	22	52	130	3.5	0	0	36	342	160	30	1.9
September	48	56	138	1.9	0	0	12	427	227	15	1.6
October	70	63	160	2.8	0.06	0	12	512	287	20	1.0
STATION P-6											
September	32	56	144	3.5	0	0	48	348	218	30	1.6
October	58	62	159	2.0	0	0	12	482	277	15	0.80
STATION P-7											
September	70	123	280	3.5	0	0	36	683	575	24	0.40
October	84	96	224	31	0.03	0	36	616	498	25	0.44

Table II-38. (Continued)

	Organics		Inorganics								
	Ortho Phosphate (PO_4)	Ammonia (N)	Boron (B)	Silica (SiO_2)	Iron (Fe)	Manganese (Mn)	Nitrite (N)	Nitrate (N)	Total Alkalinity ($CaCO_3$)	Total Hardness ($CaCO_3$)	Dissolved Solids
STATION P-1											
August	0.04	0.69	0.38	16	0.74	0	0	0.31	320	260	636
September	0.08	0	0.18	14	0.83	0	.001	0.08	410	310	716
October	0.05	0	0.17	17	0.43	0	0	.003	430	330	920
STATION P-2											
August	0	0	0.38	16	1.1	0	0	0.36	310	240	704
September	0	0	0.15	16	0.09	0	.001	0.03	410	375	756
October	0.02	0.07	0.17	18	0.12	0	0	0.26	420	420	1016
STATION P-3											
August	0	0	0.17	16	1.0	0	0	0.45	325	245	724
September	0	0	0.18	18	1.3	0	.005	0.38	370	340	764
October	0.04	0	0.18	18	0.21	0	0	0.26	430	430	956
STATION P-4											
August	0	0	0.18	61	0.26	0	0	0.34	330	270	758
September	0	0	0.15	19	0.60	0	.005	0.41	365	350	764
October	0	0	0.17	19	0.16	0	0	0.27	430	430	1016
STATION P-5											
August	0	0	0.25	17	0.43	0	0	0.44	340	270	676
September	0.02	0	0.15	19	1.1	0	0.02	.005	370	350	744
October	0.05	0.05	0.17	19	0.21	0	0	0.23	440	435	1020
STATION P-6											
September	0.07	0	0.18	18	0.19	0	0	0.37	365	310	680
October	0	0	0.18	20	1.3	0	.003	0.18	415	400	880
STATION P-7											
September	0.14	0	0.28	21	2.5	0	.006	0.09	620	680	1524
October	0.07	0.02	0.17	21	1.3	0	0	0.10	565	605	1500

Table II-38. (Concluded)

	Dissolved Oxygen (ppm)	pH	Specific Cond. (µm)	Temp. (°F)
STATION P-1				
August	7.0	8.2	1075	61
September	10.0	9.1	1125	56
October	11.0	8.1	1200	54
STATION P-2				
August	6.0	8.2	1025	59
September	11.0	8.9	1225	51
October	11.0	8.2	1300	52
STATION P-3				
August	6.0	8.2	1075	59
September	11.0	9.0	1225	51
October	11.0	8.2	1300	51
STATION P-4				
August	6.0	8.2	1075	59
September	11.0	9.1	1275	51
October	11.0	8.2	1300	51
STATION P-5				
August	6.0	8.4	1075	59
September	10.0	9.2	1300	50
October	11.0	8.3	1300	49
STATION P-6				
August	6.0	8.4	1075	59
September	10.0	8.8	1475	47
October	U.S.G.S.			
STATION P-7				
August				
September	10.0	8.8	2800	46
October	11.0	8.4	1800	40

Table II-39. MICROBIOLOGY OF PICEANCE CREEK STATIONS, TAKEN IN AUGUST, SEPTEMBER, AND OCTOBER 1974

	Standard Plate Count/ml at 35°C.	Coliform *MPN/100 ml	Fecal Coliform MPN/100 ml	Fecal Streptococci MPN/100 ml	Pathogens
STATION P-1					
August	840	4,600	43	--	--
September	1,000	43	9	<3	Not detected
October	210,000	110	<3	93	Not detected
STATION P-2					
August	1,700	4,600	43	--	--
September	210	11,000	9	<3	--
October	93,000	1,500	<3	21	--
STATION P-3					
August	7,600	4,600	240	--	--
September	190	2,400	9	<3	Not detected
October	180,000	>24,000	<3	240	Not detected
STATION P-4					
August	840	>24,000	240	--	--
September	--	--	--	--	--
October	--	--	--	--	--
STATION P-5					
August	5,100	4,600	93	--	--
September	500	1,100	1,100	<3	--
October	180,000	2,400	<3	200	--
STATION P-6					
August	8,900	>24,000	93	--	--
September	220	2,400	460	<3	--
October	--	--	--	--	--

Table II-39. (Concluded)

	Standard Plate Count/ml at 35°C.	Coliform MPN/100 ml	Fecal Coliform MPN/100 ml	Fecal Streptococci MPN/100 ml	Pathogens
STATION P-7					
August	--	--	--	--	--
September	110	390	<3	<3	Not detected
October	300,000	>24,000	<3	240	Not detected

* MPN = Most Probably Number

Table II-40. MINERAL AND NUTRIENT CONTENT (in mg/1) OF STEWART CREEK STATIONS AND LAKES, TAKEN IN AUGUST, SEPTEMBER, AND OCTOBER 1974

	Cations					Anions					
	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Ammonia (NH_4)	Hydroxide (OH)	Carbonate (CO_3)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)
STATION S-1											
August	38	89	160	2.5	0	0	36	329	442	20	1.2
September	72	77	136	0.9	0	0	12	403	377	10	4.6
October	U.S.G.S.										
STATION S-2											
August	44	77	147	1.4	0	0	18	323	384	35	4.7
September	96	63	135	1.4	0	0	12	451	394	10	2.7
October	98	74	140	1.7	0.52	0	30	458	383	15	4.9
STATION SL-1											
August	56	83	144	17	0.95	0	12	366	438	19	0.52
September	92	95	138	1.7	0	0	12	427	490	15	4.2
October	108	85	140	2.0	0.64	0	0	488	459	15	4.0
STATION SL-2											
August	20	75	134	1.9	0.41	0	24	244	376	15	3.5
September	87	73	129	1.4	0	0	12	415	410	10	3.5
October	96	75	140	1.7	0.55	0	30	451	375	15	7.1

Table II-40. (Concluded)

	Organics		Inorganics												
	Ortho Phosphate (PO_4)	Ammonia (N)	Boron (B)	Silica (SiO_2)	Iron (Fe)	Manganese (Mn)	Nitrite (N)	Nitrate (N)	Total Alkalinity ($CaCO_3$)	Total Hardness ($CaCO_3$)	Dissolved Solids	Dissolved Oxygen (ppm)	pH	Specific Cond. (µm)	Temp. (°F)
STATION S-1															
August	0.04	0	0	19	0.05	0	0	0.28	330	460	980	6.0	9.0	1400	57
September	0	0	0.17	16	0.02	0	.006	1.1	350	495	884	U.S.G.S.			
October	U.S.G.S.											U.S.G.S.			
STATION S-2															
August	0.02	0	0	16	0	0	0.01	1.1	295	425	876	7.0	9.0	1425	59
September	0	0	0.08	15	0.02	0	.006	0.61	390	500	920	----	---	----	--
October	0.03	0.40	0.17	17	0.03	0	0	1.1	425	550	956	11.0	---	1525	50
STATION SL-1															
August	0	0.74	0	14	0.07	0	0	0.12	320	480	940	4.0	7.8	1400	61
September	0	0	0.08	13	0	0	.006	0.94	370	620	1024	12.0	8.9	1600	52
October	0	0.49	0.17	15	0.04	0	.025	0.91	400	620	1064	13.0	---	1525	50
STATION SL-2															
August	0	0.32	0.03	18	0.11	0	.015	0.79	240	360	848	7.0	7.4	1600	59
September	0	0	0.08	17	0	0	.006	0.79	360	500	888	12.0	8.6	1325	48
October	0.05	0.43	0.17	17	0.04	0	.008	1.6	420	550	948	7.0	---	1425	48

Table II-41. MICROBIOLOGY OF STEWART CREEK, STATIONS AND LAKES, TAKEN IN AUGUST, SEPTEMBER, AND OCTOBER 1974

Stream Name	Standard Plate Count/ml at 35°C.	Coliform *MPN/100 ml	Fecal Coliform MPN/100 ml	Fecal Streptococci MPN/100 ml	Pathogens
STATION S-1					
August	--	--	--	--	--
September	530	240	<3	<3	--
October	--	--	--	--	--
STATION S-2					
August	--	--	--	--	--
September	200	1,000	<3	<3	--
October	380,000	>24,000	<3	93	--
STATION SL-1					
August	1,600	1,500	<3	--	--
September	320	240	<3	<3	Not detected
October	4,000	<3	<3	<3	Not detected
STATION SL-2					
August	1,500	2,400	4	--	--
September	110	43	4	<3	--
October	3,200	7	<3	<3	--

*MPN = Most Probable Number

Table II-42. MINERAL AND NUTRIENT CONTENT (in mg/l) OF WILLOW CREEK AND LAKES, TAKEN IN AUGUST, SEPTEMBER, AND OCTOBER 1974

	Cations					Anions					
	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Ammonia (NH_4)	Hydroxide (OH)	Carbonate (CO_3)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)
STATION W-1											
August	44	62	116	2.3	0	0	18	287	315	25	0.75
September	68	75	144	1.5	0	0	12	451	365	15	1.7
October	54	55	156	1.9	0.52	0	24	403	266	30	2.0
STATION W-2											
August	42	72	140	2.2	0.23	0	30	305	366	20	0.64
September	68	75	128	1.7	0	0	12	403	348	20	0.62
October	76	75	132	2.0	0.47	0	18	427	361	20	1.3
STATION W-3											
August	28	78	144	2.5	0	0	24	311	375	20	1.9
September	62	62	108	1.1	0	0	12	354	300	15	0.84
October	76	80	144	2.0	1.5	0	18	458	380	20	1.9
STATION WL-1											
August	38	74	126	1.5	0	0	60	244	331	20	0.84
September	84	58	128	0.9	0	0	12	439	305	10	0.67
October	92	68	128	1.5	0.28	0	18	451	330	70	0.84
STATION WL-2*											
October	98	77	140	1.5	0.51	0	24	500	360	15	0.19

*A new station starting October 1974

Table II-42. (Concluded)

	Organics		Inorganics												
	Ortho . Phosphate (PO_4)	Ammonia (N)	Boron (B)	Silica (SiO_2)	Iron (Fe)	Manganese (Mn)	Nitrite (N)	Nitrate (N)	Total Alkalinity ($CaCO_3$)	Total Hardness ($CaCO_3$)	Dissolved Solids	Dissolved Oxygen (ppm)	pH	Specific Cond. (µm)	Temp. (°F)
STATION W-1															
August	0.05	0	0	18	0.02	0	.005	0.17	265	365	732	8.0	7.1	1325	39
September	0.22	0	0.13	19	0	0	.006	0.37	390	480	924	10.0	8.8	1300	44
October	0	0.40	0.67	17	0.31	0	0	0.46	370	360	880	11.0	8.2	1375	43
STATION W-2															
August	0.04	0.18	0	17	0.04	0	.006	0.14	300	400	820	8.0	6.9	1350	54
September	0.02	0.14	0.17	18	0	0	.015	0.14	350	480	880	10.0	8.8	1475	48
October	0.02	0.37	0.17	19	0.12	0	0	0.30	380	500	944	10.0	8.2	1400	49
STATION W-3															
August	0.05	0	0.13	18	0.02	0	.003	0.43	295	390	792	8.0	6.7	1425	54
September	0	0	0.13	18	0	0	.005	0.19	310	410	740	9.0	8.8	1500	48
October	0.03	1.2	0.08	18	0.16	0	0	0.43	405	520	976	10.0	8.0	1475	50
STATION WL-1															
August	0	0	0.25	18	0.11	0	.015	0.19	300	400	796	8.0	7.0	1375	57
September	0	0	0.08	17	0	0	.005	0.15	380	450	800	9.0	8.6	1420	47
October	0.02	-	0.17	18	.008	0	0	0.19	400	510	908	10.0	7.8	1375	48
STATION WL-2															
October	0.03	0.39	0.17	21	0.03	0	.005	0.19	450	560	988	5.0	7.8	1450	46

Table II-43. MICROBIOLOGY OF WILLOW CREEK, STATIONS AND LAKES, TAKEN IN AUGUST, SEPTEMBER, AND OCTOBER 1974

Stream Name	Standard Plate Count/ml at 35°C.	Coliform MPN/100 ml	Fecal Coliform MPN/100 ml	Fecal Streptococci MPN/100 ml	Pathogens
STATION W-1 #1					
August	340	4,600	93	--	--
September	1,300	4,600	<3	<3	Not detected
October	TNTC	1,100	<3	240	Not detected
STATION W-2 #2					
August	95	240	23	--	--
September	460	1,200	<3	<3	--
October	13,000	460	<3	150	--
STATION W-3 #3					
August	2,200	390	43	--	--
September	520	24,000	<3	<3	--
October	69,000	2,400	<3	21	--
STATION WL-1 Creek					
August	--	--	--	--	--
September	110	23	<3	<3	--
October	7,700	23	<3	<3	--
STATION WL-2 Creek					
August	340	150	93	--	--
September	--	--	--	<3	--
October	2,300	<3	<3	<3	--

Table II-44. MINERAL AND NUTRIENT CONTENT (in mg/l) OF THE WHITE RIVER STATIONS, TAKEN IN AUGUST, SEPTEMBER, AND OCTOBER 1974

	Cations					Anions					
	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Ammonia (NH_4)	Hydroxide (OH)	Carbonate (CO_3)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)
STATION WR-1											
August	74	19	35	1.9	0.18	0	12	171	143	39	0
September	88	22	35	1.2	0	0	12	195	130	35	0.18
October	74	21	35	1.9	0	0	0	183	147	35	0
STATION WR-2											
August	116	11	59	2.2	0.18	0	6	244	153	59	0
September	88	22	49	1.5	0	0	18	207	153	30	0.04
October	76	22	54	1.7	0	0	0	226	162	40	0.03

Table II-44. (Concluded)

	Organics		Inorganics												
	Ortho Phosphate (PO_4)	Ammonia (N)	Boron (B)	Silica (SiO_2)	Iron (Fe)	Manganese (Mn)	Nitrite (N)	Nitrate (N)	Total Alkalinity ($CaCO_3$)	Total Hardness ($CaCO_3$)	Dissolved Solids	Dissolved Oxygen (ppm)	pH	Specific Cond. (µm)	Temp. (°F)
STATION WR-1															
August	0	0.14	0	15	0.31	0	0	0	160	265	424	8.0	7.4	675	59
September	0	0	0	14	0.49	0	.003	0.04	180	300	440	10.0	8.8	740	51
October	0.07	0	0	16	0.44	0	0	0	150	270	462	10.0	8.0	700	43
STATION WR-2															
August	0	0.14	0.13	16	0.16	0	0	0	210	335	512	9.0	7.8	750	61
September	0	0	0.08	14	0.35	0	.001	0.01	200	310	472	9.0	8.8	820	51
October	0	0	0	15	0.36	0	0	.006	185	280	468	10.0	8.0	720	43

Table II-45. MICROBIOLOGY OF THE WHITE RIVER STATIONS, TAKEN IN AUGUST, SEPTEMBER, AND OCTOBER 1974

Stream Name	Standard Plate Count/ml at 35°C.	Coliform MPN/100 ml	Fecal Coliform MPN/100 ml	Fecal Streptococci MPN/100 ml	Pathogens
Station WR-1					
August	990	2,400	240	--	--
September	1,700	>24,000	<3	<3	Not detected
October	3,700	4,600	<3	23	Not detected
Station WR-2					
August	840	750	460	--	--
September	2,000	460	<3	<3	--
October	6,200	11,000	<3	9	--

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III

TERRESTRIAL VEGETATION STUDIES

The vegetation studies on Tract C-b are designed to provide baseline ecological data on the structural, compositional, and functional aspects of the terrestrial vegetation, with an ultimate objective of supplying the data necessary for producing a general ecosystem model of the tract--to the extent possible. Some of the major interactions between vegetation and environment as well as interactions among trophic levels will be described.

Because the federal oil shale lease is not specific in its requirements for study of the flora (Oil Shale Lease Environmental Stipulations, sections 1c, 2d), we have interpreted the lease to require a comprehensive study of the existing vegetation in sufficient detail that future changes in species composition or vegetation structure and function can be detected by comparison with pre-development baseline ecological data.

Ecologists have recently become more concerned with functional aspects of ecosystems--as is evidenced by the detailed International Biological Program (IBP) studies of the major biomes of the world. These studies have utilized a combination of existing information and new research to produce models of the major biomes. Much of the success of the IBP studies can be attributed to the abundance of preexisting data which was utilized not only for inclusion in models

but also as a basis for determining the scope and type of studies necessary for constructing predictive models. Our approach to the study of vegetation on Tract C-b has been influenced by the multi-disciplinary IBP designs; however, our objectives are not as broad as those of the IBP. Our concern is with accumulating baseline data similar to those which were already available for the IBP researchers. Consequently, our data will not only be useful for future comparative purposes but will also serve as a springboard for future research necessary to answer or test the questions and hypotheses generated by this initial study.

This report summarizes the activities and initial results of the first quarter of a two-year study program. Subsequent reports will delve more deeply into those components of the study which have only just begun, or which will commence at the beginning of next year's growing season.

METHODOLOGY

Vegetation Mapping

The final vegetation map of the tract will be producd at a scale of 1:12,000 using a modification of Küchler's comprehensive mapping techniques (Küchler, 1967). This procedure begins with examination of aerial photos of the site. After careful examination, lines are drawn around areas of homogeneous texture and tone on the photographs, thus forming a mosaic of various-sized and -shaped patches. Each area delimited on the photographs is then field-checked, and notes are taken on the dominant species on the site. Information from the field-checking is used to verify established vegetation types, and each of the delimited areas is then assigned to one of these types.

The information which is portrayed on the photographs is then transferred to a base map (in this case, a 1:12,000 topographic map of the tract) by using an appropriate instrument, such as a zoom-transfer scope.

Floristic Studies

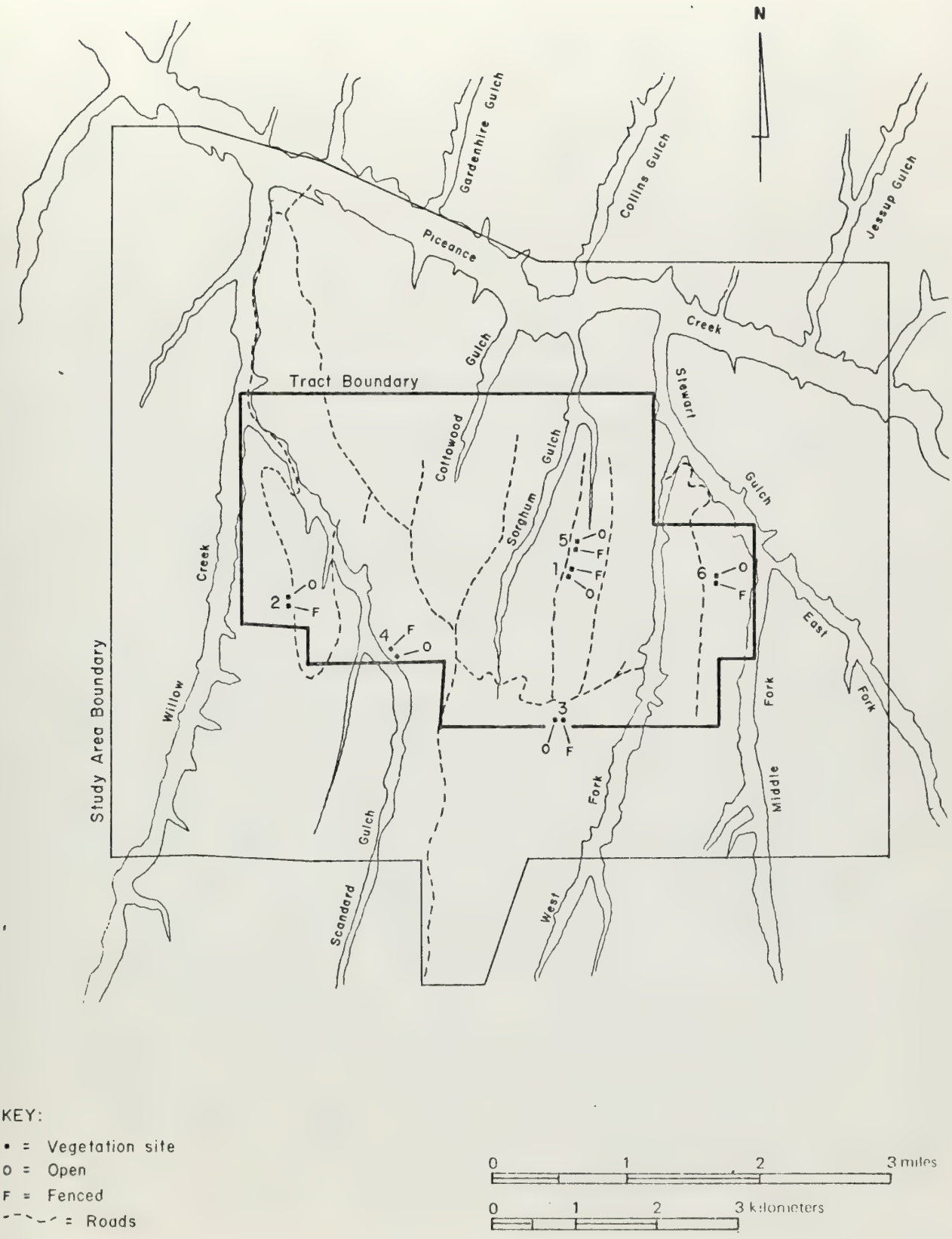
Collection of both vascular and nonvascular terrestrial and aquatic plants which occur within the tract study area will be made. Identifications and nomenclature for vascular plants will follow Harrington (1964) and Weber (1972); mosses will follow Weber (1973); lichens, where appropriate, will follow Hale (1969); and fungi will follow Wells and Mitchel (1966).

Final annotated species lists for vascular plants will include both scientific and common names, life form (Raunkiaer, 1934), abundance statement, community affinity, and distributional status (Scoggan, 1957). Lists for nonvascular plants will be more abbreviated and will include scientific name, abundance statement (where possible), and general habitat. All collections will be properly identified with standard herbarium labels.

Phytosociological Studies

Twelve permanent intensive study plots (Figure III-1) are used for major phytosociological studies. An additional sampling program will provide general descriptive data for all the plant communities within Tract C-b.

One of the best ways to detect vegetation changes over long time periods is by repeated sampling of permanent plots. On Tract C-b, where vegetation changes are of considerable importance, we have established twelve permanent plots (Figure III-1) at six locations. Each plot (50 by 70 meters; except site 5, which is 50 by 90 meters) contains 25 permanent 1-centare quadrats and 20 belt transects (4 by 10 meters) which are located in a grid 40 meters square, at one end of



KEY:

• = Vegetation site
O = Open
F = Fenced
- - - = Roads

0 1 2 3 miles

0 1 2 3 kilometers

Figure III-1. VEGETATION STUDY AREAS

the plot. The 1-centare quadrats are used in measuring herbaceous cover, while the belt transects are used for sampling shrubs (Lindsey, 1955). The remainder of the plot will be utilized for productivity, phenology, and decomposition studies. At each location one of the paired plots is fenced (2.5-meter deer fence), and the other is left open. This will allow us to determine what effects grazing has on the vegetation. The study plots are located in the major vegetation types (sagebrush shrubland, pinyon-juniper woodland, and chained pinyon-juniper woodland), and are positioned so that one pair of plots is located near sites of anticipated development on the site, and the other pair of plots in the same vegetation type is located on a remote part of the tract where no impact from development is anticipated. With this design, four treatments on the vegetation can be monitored:

- oil shale development and grazing
- oil shale development and no grazing
- no oil shale development and grazing
- no oil shale development and no grzing.

Long-term data from this study will allow investigators to analyze vegetation changes in the proper perspective. The data below have been collected in each of the intensive study plots. Dates of data collection will be supplied in the next quarterly report.

Trees. In the 1600 square meters defined by the corner quadrats at sites 5 and 6, all of the trees have been measured and tagged. Trees have been marked with aluminum tags which are nailed into the trunk at the height of diameter measurement.

Data Recorded	Method
Diameter at breast height (DBH)	Diameter tape
Height	Clinometer
Canopy cover (will be measured next year)	Vertical projection of cover onto a tape stretched along the ground; "dizzy stick method"

Herb Quadrats

Data Recorded	Method
Herbaceous species present	Observation
Woody species present (<25 cm tall)	Observation
Cover by herbaceous plants	Visual estimate
Cover by woody plants <25 cm tall	Visual estimate
Cover by rocks	Visual estimate
Cover by bare soil	Visual estimate
Cover by mosses	Visual estimate
Cover by crustose lichens	Visual estimate
Cover by foliose and fruticose lichens	Visual estimate
Litter cover	Visual estimate

Shrub Belt Transects

Data Recorded	Method
Woody species present (frequency)	Observation
Cover by Woody species >25 cm tall (dominance)	Line intercept
Number of individuals of each species by height class (Density)	Actual count

Additional Sampling. The intensive study plots are located in the most widespread vegetation types. In order to obtain the necessary data for discription of the other vegetation types, selected stands of these other plant communities will be sampled. Quadrat and shrub transect sampling will provide structural and compositional data; however, no phenological or functional information will be obtained for these areas. Additional stands of the major vegetation types will also be sampled in order to determine amounts of variability within these types.

Forested stands will be sampled using the quarter method (Cottam and Curtis, 1956) rather than a quadrat approach, as has been used in the intensive study plots.

Productivity Studies

Productivity within the herb layer of the major vegetation types will be estimated by clipping randomly located 0.1-square-meter quadrats at intervals throughout the growing season. Shrub productivity will be estimated by repeated clipping of selected shrubs. (More detailed methods will be given as this portion of the study gets underway.)

Decomposition Studies

The decomposition experiment consists of two areas of study. In the first of these, decomposition bags are used to determine the rate at which plant litter decomposes in the major vegetation types. In keeping with the methods utilized in IBP studies (B. Ausmus, Oak Ridge National Laboratory, personal communication; local plant materials (leaves from mountain mahogany, serviceberry, and sagebrush), as well as a cellulose standard (Watman #50 filter paper) have been used for this study. The decomposition materials (approximately 2 grams of leaves) have been placed in nylon mesh bags (7 by 7 centimeters), weighed, and then placed in the field. After a specified length of time (one or two years) the bags will be recovered and weighed; the loss of weight is a measure of the rate of decomposition. We are studying decomposition on the surface as well as at a depth of 10 centimeters. Distribution of the 640 decomposition bags in the intensive study plots on Tract C-b is as follows:

- Mountain mahogany: 10 bags on the surface and 10 bags at a depth of 10 cm in plots 1-F, 1-0, 2-F, 2-0, 5-F, 5-0, 6-F, and 6-0 (160 bags)

- Serviceberry: 10 bags on the surface and 10 bags at at a depth of 10 cm in plots 1-F, 1-0, 2-F, 2-0, 5-F, 5-0, 6-F, and 6-0 (160 bags)
- Big sagebrush: 10 bags on the surface and 10 bags at a depth of 10 cm in plots 3-F, 3-0, 4-F, and 4-0 (80 bags)
- Cellulose standard: 10 bags on the surface and 10 bags at a depth of 10 cm in all plots (240 bags).

In the second part of the decomposition study, litter traps are used to determine the rate of litter fall in the major plant communities. One hundred twenty litter traps (0.25 square meter in size) (Bray and Gorham 1964), 10 in each study plot, have been placed on the tract. Litter from these traps will be collected at intervals throughout the year, dried, and weighed in order to estimate the rate at which dead plant material is made available to decomposer organisms.

Phenological Studies

Phenological observations for shrubs will be restricted to the same species being used for the decomposition studies. Individual twigs on plants of these species have been marked and measured so that it will be possible to document growth and development of each shrub (Harvey, 1972). Number and locations of the marked shrubs are as follows:

Plot Location	Number of Plants		
	Amelanchier alnifolia	Cercocarpus montanus	Artemisia tridentata
1-F	5	5	
1-0	5	5	
2-F	5	5	
2-0	5	5	
3-F			5
3-0			5
4-F			5
4-0			5
5-F	5	5	

Plot Location	Amelanchier alnifolia	Cercocarpus montanus	Artemisia tridentata
5-0	5	5	
6-F	5		
6-0	5		
Total plants	40	30	20
Total twigs	160	120	80

Data recorded for each twig and each plant include:
(1) graphic representation of twig
(2) general vigor
(3) presence or absence of insect galls
(4) extent of mechanical damage
(5) length of twig
(6) number of nodes, leaves, lateral buds, and terminal buds.

Phenology of herbaceous species will be monitored throughout the growing season in the permanent quadrats of the intensive study plots.

Successional Studies

The successional studies will depend on data collected in the phytosociological studies. In addition to this information, regional and local observation and sampling of disturbed sites will be utilized. With these techniques we can discover the normal sequence of changes that plant communities undergo following disturbance.

Analytical Method

An abundance of phytosociological data will be accumulated throughout this study, and meaningful analysis of these data will be approached through ordination (Bray and Curtis, 1957; Swan, Dix, and Wehrhahn, 1967) and direct gradient analysis techniques (Whittaker, 1967). The objective of the direct and indirect gradient analyses will be to determine those environmental parameters which are most strongly related to changes in plant community structure and composition.

RESULTS AND DISCUSSION

Vegetation Mapping

Initial field-checking and interpretation of aerial photographs have been completed. Black-and-white, color, and color infrared photographs, supplied by the client, are being used in producing the vegetation map. The combination of photograph interpretation and field-checking suggests that 14 vegetation types may be appropriate for defining the existing vegetation. The vegetation types and their dominant species are listed below.

Vegetation Type	Dominant Species	
Pinyon-juniper woodland/ Open understory	Trees:	Pinus edulis Juniperus osteosperma Juniperus scopulorum
Pinyon-juniper woodland/ Shrubby understory	Trees:	Pinus edulis Juniperus osteosperma Juniperus scopulorum
	Shrubs:	Amelanchier alnifolia Cercocarpus montanus Symphoricarpos oreophilus
Douglas-fir forest	Pseudotsuga menziesii	
Chained pinyon-juniper woodland	Shrubs:	Artemisia tridentata Cercocarpus montanus Purshia tridentata
	Saplings:	Pinus edulis Juniperus osteosperma Juniperus scopulorum
Valley sagebrush community	Artemisia tridentata Eurotia lanata Chrysothamnus nauseosus	
Ridgetop sagebrush community	Artemisia tridentata	
Rabbitbrush community	Chrysothamnus nauseosus	

Greasewood community	Sarcobatus vermiculatus
Mixed mountain shrub community	Quercus gambelii Amelanchier alnifolia Cercocarous montanus Symphoricarpos oreophilus Artemisia tridentata
Bunchgrass community	Oryzopsis hymenoides Agropyron spicatum Eriogonum lonchophyllum (?) Artemisia ludoviciana Artemisia frigida
Marsh	Typha latifolia Phragmites communis Carex spp.
Hay meadows	Medicago sativa Phleum pratense Carex spp.
Annual weed communities (disturbed sites)	Salsola kali Amaranthus albus Lepidium montanum
Sprayed sagebrush sites	Artemisia tridentata Chrysothamnus nauseosus Eurotia lanata

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Floristic Studies

Initial floristic work on the tract has focused on the vascular plants. To date, approximately 190 species (Table III-1) have been identified, and collections of many of these have been made. No rare or endangered species have as yet been located; most of the species are common and characteristic of west-central Colorado. There are uncommon species on the tract--but in any area it is possible to find species existing at the edge of their ecological tolerances. On Tract C-b, narrow-leaved cottonwood (populus angustifolia) and box elder (Acer negundo) fall into this category.

Table III-1. VASCULAR PLANT SPECIES FOR TRACT C-b
(Updated December 2, 1974).

Scientific Name	Common Name	Family
	TREES, SHRUBS, WOODY VINES, AND STEM SUCCULENTS	
Acer negundo	Box elder	Aceraceae
Amelanchier alnifolia	Serviceberry	Rosaceae
Artemisia tridentata	Big sagebrush	Compositae
Atriplex canescens	Four-winged saltbush	Chenopodiaceae
Atriplex confertifolia	Shadscale	Chenopodiaceae
Cerococarpus montanus	Mountain mahogany	Rosaceae
* Chrysothamnus nauseosus	Rubber rabbitbrush	Compositae
* Chrysothamnus viscidiflorus	Rabbitbrush	Compositae
Clematis ligusticifolia	Western virgin's bower	Ranunculaceae
Clematis pseudoalpina	Virgin's bower	Ranunculaceae
Ephedra viridis	Mormon tea	Gnetaceae
Eriogonum lonchophyllum (?)	Wild buckwheat	Polygonaceae
Eurotia lanata	Winter fat	Chenopodiaceae
* Gutierrezia sarothrae	Snakeweed	Compositae
Holodiscus dumosus	Rock spirea	Rosaceae
Humulus lupulus	Wild hops	Moraceae
* Juniperus osteosperma	Utah juniper	Cupressaceae
Juniperus scopulorum	Rocky Mountain juniper	Cupressaceae
Mahonia repens	Oregon grape	Berberidaceae
Opuntia polyacantha	Prickly pear	Cactaceae
Pinus edulis	Pinyon pine	Pinaceae
Populus angustifolia	Narrow-leaf cottonwood	Salicaceae

Table III-1 (Continued)

Scientific Name	Common Name	Family
Prunus virginiana	Chokecherry	Rosaceae
Pseudotsuga menziesii	Douglas-fir	Pinaceae
Purshia tridentata	Antelope bitterbrush	Rosaceae
Quercus gambelii	Gambel oak	Fagaceae
* Ribes aureum	Golden currant	Grosulariaceae
* Ribes cereum	Currant	Grosulariaceae
Ribes inerme	Smooth currant	Grosulariaceae
Rhus trilobata	Skunkbush	Anacardiaceae
Rosa woodsii	Wild rose	Rosaceae
* Salix sp.	Willow	Salicaceae
Sarcobatus vermiculatus	Greasewood	Chenopodiaceae
Shepherdia argentea	Silver buffaloberry	Eleagnaceae
* Symphoricarpos oreophilus	Snowberry	Caprifoliaceae
Tetradymia canescens	Horsebrush	Compositae
Ulmus pumila	Siberian elm	Ulmaceae
	HERBACEOUS SPECIES	
* Achillea lanulosa	Yarrow	Compositae
Agoseris glauca	False dandelion	Compositae
* Agropyron cristatum	Crested wheatgrass	Gramineae
Agropyron smithii	Western wheatgrass	Gramineae
Agropyron spicatum	Blue-bunch wheatgrass	Gramineae

Table III-1 (Continued)

	Scientific Name	Common Name	Family
	Agropyron trachycaulum (?)	Slender wheatgrass	Gramineae
*	Agrostis alba	Red top	Gramineae
	Amaranthus albus	Pigweed	Amaranthaceae
	Amaranthus retroflexus	Pigweed	Amaranthaceae
	Amaranthus sp.	Pigweed	Amaranthaceae
	Ambrosia artemisifolia	Ragweed	Compositae
	Androsace septentrionalis	Fairy candelabra	Primulaceae
*	Antennaria parvifolia	Pussytoes	Compositae
	Antennaria rosea	Pussytoes	Compositae
	Apocynum androsaemifolium	Dogbane	Apocynaceae
	Arabis holboellii (?)	Rock cress	Cruciferae
*	Artemisia biennis	Biennial sage	Compositae
*	Artemisia dracunculus glauca	Green sage	Compositae
*	Artemisia frigida	Pasture sage	Compositae
*	Artemisia ludoviciana	Sagewort	Compositae
	Asclepias speciosa	Showy milkweed	Asclepiadaceae
*	Aster fendleri	Aster	Compositae
*	Aster frondosus	Short-rayed alkali aster	Compositae
	Aster glaucodes (?)	Glaucous aster	Compositae
	Aster sp.	Aster	Compositae
	Astragalus kentrophyta	Kentrophyta milk vetch	Leguminosae
	Astragalus (several species)	Milk vetch	Leguminosae

Table III-1 (Continued)

Scientific Name	Common Name	Family
* Atriplex sp.	Saltbush	Chenopodiaceae
Balsamorhiza sagittata	Balsam root	Compositae
* Beckmannia syzigachne	Sloughgrass	Gramineae
* Brickellia grandiflora	Tassel flower brickellbush	Compositae
Bromus anomalus (?)	Nodding brome	Gramineae
Bromus inermis	Smooth brome	Gramineae
Bromus japonicus	Japanese brome	Gramineae
Bromus tectorum	Cheatgrass	Gramineae
* Bouteloua gracilis	Blue grama	Gramineae
Calochortus gunnisonii	Mariposa lily	Liliaceae
Calochortus nuttallii	Mariposa lily	Liliaceae
Camelina microcarpa	False flax	Cruciferea
Castilleja chromosa (?)	Indian paintbrush	Scrophulariaceae
Castilleja linariaefolia	Indian paintbrush	Scrophulariaceae
Chamaesyce sp.	Spurge	Euphorbiaceae
Chenopodium fremontii	Goosefoot	Chenopodiaceae
* Chenopodium sp.	Lamb's quarters	Chenopodiaceae
Cirsium arvense	Canada thistle	Compositae
Cirsium sp.	Thistle	Compositae
Clematis hirsutissima	Sugarbowls	Ranunculaceae
Cleome serrulata	Bee plant	Capparidaceae
Comandra umbellata	Bastard toadflax	Santalaceae

Table III-1 (Continued)

Scientific Name	Common Name	Family
Conyza canadensis	Horseweed	Compositae
Corydalis aurea	Golden smoke	Fumariaceae
Cryptantha sp.	Cryptantha	Boraginaceae
Dactylis glomerata	Orchardgrass	Gramineae
Delphinium nelsoni	Larkspur	Ranunculaceae
Descurainia pinnata	Tansy mustard	Cruciferae
* Echinochloa crusgalli mitis	Barnyard grass	Gramineae
Elymus cinereus	Great Basin wildrye	Gramineae
Epilobium sp.	Fireweed	Onagraceae
Equisetum hyemale (?)	Horsetail	Equisetaceae
* Equisetum kansanum	Horsetail	Equisetaceae
Equisetum arvense	Horsetail	Equisetaceae
Erigeron utahensis	Fleabane	Compositae
* Eriogonum alatum	Winged eriogonum	Polygonaceae
* Eriogonum cernuum	Nodding eriogonum	Polygonaceae
Eriogonum flexum (?)	Eriogonum	Polygonaceae
Eriogonum umbellatum	Sulphur-flower	Polygonaceae
* Euphorbia robusta	Spurge	Euphorbiaceae
Festuca ovina	Sheep fescue	Gramineae
Galium coloradoense	Colorado bedstraw	Rubiaceae
* Gayophytum ramosissimum	Much-branched gayophytum	Onagraceae
* Glycyrrhiza lepidota	Wild licorice	Leguminosae

Table III-1 (Continued)

Scientific Name	Common Name	Family
Grindelia squarrosa	Curly-cup gumweed	Compositae
* Haplopappus nuttallii	Haplopappus	Compositae
Helianthus annuus	Common sunflower	Compositae
Helianthus nuttallii	Nuttall's sunflower	Compositae
Hedysarum boreale	Sweet vetch	Leguminosae
* Heterotheca villosa	Golden aster	Compositae
Heuchera parvifolia	Alumroot	Saxifragaceae
* Hordeum jubatum	Foxtail barley	Gramineae
* Ipomopsis aggregata	Scarlet gilia	Polemoniaceae
Iva xanthifolia	Marsh-elder	Compositae
* Juncus balticus	Baltic rush	Juncaceae
Koeleria cristata	Junegrass	Gramineae
Lactuca pulchella	Prickly lettuce	Compositae
Lactuca serriola	Blue lettuce	Compositae
* Lappula redowskii	Stickseed	Boraginaceae
* Lepidium montanum	Mountain peppergrass	Cruciferae
* Lepidium perfoliatum	Peppergrass	Cruciferae
Linum lewisii	Wild flax	Linaceae
Lithospermum sp.	Puccoon	Boraginaceae
Lolium perenne	Darnel	Gramineae
Lupinus argenteus (?)	Lupine	Leguminosae
* Lupinus sp.	Lupine	Leguminosae

Table III-1 (Continued)

Scientific Name	Common Name	Family
Lygodesmia grandiflora	Skeletonweed	Compositae
Malcolmia africana	Malcolmia	Cruciferae
Medicago sativa	Alfalfa	Leguminosae
Melilotus alba	White sweet clover	Leguminosae
Melilotus officinalis	Yellow sweet clover	Leguminosae
Mentzelia rusbyi	Evening-star	Loasaceae
Mentzelia sp.	Evening-star	Loasaceae
Oenothera caespitosa	Gumbo lily	Onagraceae
Oenothera lavandulaefolia	Evening primrose	Onagraceae
Oenothera sp.	Evening primrose	Onagraceae
Oenothera strigosa	Evening primrose	Onagraceae
* Oenothera trichocalyx	Evening primrose	Onagraceae
Onosmodium molle	False gromwell	Boraginaceae
* Oryzopsis hymenoides	Indian ricegrass	Gramineae
Oryzopsis micrantha	Little ricegrass	Gramineae
Oxybaphus linearis	Umbrella-wort	Nyctaginaceae
Penstemon sp.	Penstemon	Scrophulariaceae
Phacelia idahoensis (?)	Phacelia	Hydrophyllaceae
Phlox hoodii (?)	Dwarf phlox	Polemoniaceae
Phlox longifolia	Long-leaved phlox	Polemoniaceae
* Phleum pratense	Timothy	Gramineae
* Phragmites communis	Common reed	Gramineae

Table III-1 (Continued)

Scientific Name	Common Name	Family
Physaria floribunda	Double bladderpod	Cruciferae
Poa fendleriana	Mutton-grass	Gramineae
Poa pratensis	Kentucky bluegrass	Gramineae
* Polypogon monspeliensis	Rabbit's-foot grass	Gramineae
Potentilla sp.	Cinquefoil	Rosaceae
Pulsatilla patens	Pasque flower	Ranunculaceae
* Ranunculus cymbalaria	Desert buttercup	Ranunculaceae
Rorippa nasturtium-aquaticum	Water cress	Cruciferae
Rumex sp.	Dock	Polygonaceae
Salsola kali	Russian thistle	Chenopodiaceae
* Scirpus paludosus	Prairie bulrush	Cyperaceae
Scirpus validus	Tule	Cyperaceae
Senecio eremophilus var. kingii	Ragwort	Compositae
Senecio multilobatus	Ragwort	Compositae
Sidalcea neomexicana (?)	Checker mallow	Malvaceae
* Sisymbrium altissimum	Tumble mustard	Cruciferae
Sitanion longifolium	Squirrel-tail grass	Gramineae
Smilacina stellata	False soloman's seal	Liliaceae
* Solidago canadensis	Meadow goldenrod	Compositae
Solidago sparsifolia (?)	Goldenrod	Compositae
Sonchus arvensis (?)	Sow thistle	Compositae
* Sphaeralcea coccinea	Scarlet globemallow	Malvaceae

Table III-1 (Concluded)

Scientific Name	Common Name	Family
Sporobolus cryptandrus (?)	Sand dropseed	Gramineae
Stipa comata	Needle-and-thread grass	Gramineae
Streptanthus cordatus	Twistflower	Cruciferae
Taraxacum officinale	Dandelion	Compositae
Townsendia hookeri (?)	Easter daisy	Compositae
* Townsendia incana	Easter daisy	Compositae
Tragopogon dubius	Goat's beard	Compositae
Trifolium gymnocarpon	Clover	Leguminosae
* Triglochin maritima	Seaside arrowgrass	Juncaginaceae
Tripterocalyx micranthus	Winged fruited sand verbena	Nyctaginaceae
Typha latifolia	Cattail	Typhaceae
Urtica dioica	Stinging nettle	Urticaceae
Veronica salina	Speedwell	Scrophulariaceae
Yucca glauca	Yucca	Liliaceae
Zygadenus venenosus	Death camas	Liliaceae

(?) indicates uncertain specific identification

* those plants in the herbarium at Woodward-Envicon Inc.

A few collections of fungi, lichens, and mosses have been made, but none have been identified as yet.

Phytosociological Studies

Intensive Study Plots. Much of the field work during this first quarter was centered on initial sampling of the intensive study plots. The type of data obtained is outlined in the Methodology section. In the discussion that follows, each site will be treated separately and will be followed by general comments on the combined intensive sites. Most of the data presented are about shrubs. Data from the herb layer are limited, since many of the herbaceous components had completed their yearly growth before sampling began.

For this first quarterly report the site descriptions are based on combined data from the fenced and open plots, since there should be no grazing differences apparent in the initial sample. In subsequent reports the data will be treated separately, as we look for vegetation changes that may result from the removal of grazing pressures.

Site 1. Chained Pinyon-Juniper Disturbed Site. The chained pinyon-juniper woodland at site 1 is similar in appearance to the rest of the chained areas on the tract. The dead trees that cover much of the surface give the area a disorderly appearance. The site is grazed by livestock and deer; however, there are places under the felled trees where grazing and browsing are prevented. Because cattle tend to move around the dead trees, grazing pressures are not uniform.

Pinyon-juniper woodlands tend naturally not to have a completely closed canopy, and even in dense stands clearings are common. One of the most apparent effects of chaining has been the complete opening of the woodland canopy. Since chaining there has been some recovery by the pinyons (Pinus edulis) and junipers (Juniperus osteosperma and J. scopulorum). Approximately 2 percent of site 1 is covered by these

species (Table III-2). With increased amounts of solar radiation and reduced competition with trees, the shrubs and saplings of the original woodland have greater opportunities for growth. The site as it exists now is a shrub community dominated by big sagebrush, antelope bitterbrush (Purshia tridentata), rabbitbrush (Chrysothamnus nauseosus), and mountain mahogany (Cercocarpus montanus). These four species account for 81 percent of the shrub cover (Table III-2), 62 percent of shrub frequency (Table III-3), 81 percent of shrub density (Table III-4), and 75 percent of the shrub importance value (Table III-5). (See Table III-2 through Table III-5 for definitions pertaining to cover, frequency, density, and importance value.) There are eight other species in the shrub layer at the site.

Initial data from the herb quadrats (Table III-6) indicate the sparseness of herbaceous cover in the ground layer. The late season observations may well be misleading, and data from next season may show more substantial development of herbaceous species. Much of the ground surface (62 percent) is covered by litter.

Site 2. Chained Pinyon-Juniper Control Site. The chained pinyon-juniper control site is also a community dominated by shrubs and saplings. There has been greater recovery by the tree species on this site, to the degree that juniper and pinyon saplings are the dominant species (64 percent and 50 percent importance value, respectively). The same four shrub species which are so prevalent at site 1 are also important components of the vegetation at site 2, where they constitute 57 percent of the cover (Table III-7), 45 percent of the frequency (Table III-8), 48 percent of the density (Table III-9), and 50 percent of the importance value (Table III-10). In addition to these species, serviceberry (Amelanchier alnifolia) also assumes a prominent position in the shrub layer.

The conditions in the herb layer at site 2 are similar to those at site 1. Cover by herbs is limited, and there are few mosses and lichens.

Table III-2. PERCENT GROUND COVER* AND PERCENT COMPOSITION** OF TREES (DBH <10 cm)*** AND SHRUBS AT SITE 1 (chained pinyon-juniper disturbed site)

Species	Fenced Plot		Open Plot	
	Ground Cover	Composition	Ground Cover	Composition
TREES (Saplings)				
Juniperus osteosperma	0.2	2.2	0.6	3.8
J. scopulorum	0.0	0.0	1.0	6.6
Pinus edulis	0.2	2.8	0.8	5.5
SHRUBS				
Amelanchier alnifolia	0.6	6.6	0.3	2.1
Artemisia tridentata	5.3	58.6	9.6	66.8
Cercocarpus montanus	0.1	1.1	0.4	3.1
Chrysothamnus nauseosus	1.4	15.5	0.4	2.8
Gutierrezia sarothrae	0.5	5.5	0.0	0.0
Purshia tridentata	0.6	6.6	1.2	8.3
Symphoricarpos oreophilus	0.1	1.1	0.2	1.0
TOTALS	9.0	100.0	14.5	100.0

*Percent ground cover = $\frac{\Sigma \text{ of intercepts of species A}}{\text{total length of line transect}} \times 100$

**Percent composition = relative cover = $\frac{\Sigma \text{ of intercepts of species A}}{\Sigma \text{ of intercepts of all species}} \times 100$

Note: percent composition is calculated from intercept measurements and not percent ground cover values, which are rounded off.

***DBH = diameter at breast height

Table III-3. PERCENT FREQUENCY OF TREES (DBH <10 cm)[a], SHRUBS, AND SUCCULENTS AT SITE 1 (chained pinyon-juniper disturbed site)

Species	Fenced Plot		Open Plot	
	Absolute Frequency[b]	Relative Frequency[c]	Absolute Frequency	Relative Frequency
TREES (Saplings)				
Juniperus osteosperma	25	7.5	40	8.7
J. scopulorum	5	1.5	5	1.1
Pinus edulis	25	7.5	55	12.0
SHRUBS				
Amelanchier alnifolia	0	0.0	40	8.7
Artemisia tridentata	80	23.9	100	21.8
Cercocarpus montanus	50	14.9	65	14.1
Chrysothamnus nauseosus	50	14.9	30	6.5
C. viscidiflorus	5	1.5	5	1.1
Gutierrezia sarothrae	15	4.5	5	1.1
Purshia tridentata	50	14.9	65	14.1
Symphoricarpos oreophilus	20	5.9	30	6.5
SUCCULENTS				
Opuntia polyacantha	10	3.0	20	4.3
TOTALS		100.0		100.0

[a] DBH = diameter at breast height

[b] Absolute frequency = $\frac{\text{number of plots containing species A}}{\text{total number of plots}} \times 100$

[c] Relative frequency = $\frac{\text{absolute frequency of species A}}{\Sigma \text{ of absolute frequency for all species}} \times 100$

Table III-4. DENSITY OF TREES (DBH <10 cm),* SHRUBS, AND SUCCULENTS AT SITE 1 (chained pinyon-juniper disturbed site)

	Fenced Plot			Open Plot		
	Absolute Density		Relative Density**	Absolute Density		Relative Density
	#/Plot	#/Hectare	(%)	#/Plot	#/Hectare	(%)
TREES (Saplings)						
Juniperus osteosperma						
Class 1	3	37.5	1.3	3	37.5	0.8
Class 2	2	25.0	0.8	5	62.5	1.3
TOTAL	5	62.5	2.1	8	100.0	2.1
J. scopulorum						
Class 1	1	12.5	0.4	0	0.0	0.0
Class 2	0	0.0	0.0	2	25.0	0.5
TOTAL	1	12.5	0.4	2	25.0	0.5
Pinus edulis						
Class 1	10	125.0	4.2	11	137.5	2.9
Class 2	3	37.5	1.2	10	125.0	2.6
TOTAL	13	162.5	5.4	21	262.5	5.5

*DBH = Diameter at breast height

**Relative density = $\frac{\text{number of species A}}{\text{number of all species}} \times 100$

Table III-4. (Continued)

	Fenced Plot			Open Plot		
	Absolute Density		Relative Density	Absolute Density		Relative Density
	#/Plot	#/Hectare	(%)	#/Plot	#/Hectare	(%)
SHRUBS						
Amelanchier alnifolia						
Class 1	2	25.0	0.8	13	162.5	3.5
Class 2	1	12.5	0.4	2	25.0	0.5
TOTAL	3	37.5	1.2	15	187.5	4.0
Artemisia tridentata						
Class 1	79	987.5	33.3	170	2125.0	45.2
Class 2	48	600.0	20.3	52	650.0	13.8
Class 3	1	12.5	0.4	1	12.5	0.3
TOTAL	128	1600.	54.0	223	2787.5	59.3
Cercocarpus montanus						
Class 1	11	137.5	4.6	21	262.5	5.6
Class 2	9	112.5	3.8	7	87.5	1.9
TOTAL	20	250.0	8.4	28	350.0	7.5
Chrysothamnus nauseosus						
Class 1	21	262.5	8.9	13	162.5	3.5
Class 2	1	12.5	0.4	2	25.0	0.5
TOTAL	22	275.0	9.3	15	187.5	4.0

Table III-4. (Concluded)

	Fenced Plot			Open Plot		
	Absolute Density		Relative Density	Absolute Density		Relative Density
	#/Plot	#/Hectare	(%)	#/Plot	#/Hectare	(%)
C. viscidiflorus						
Class 1	1	12.5	0.4	1	12.5	0.3
TOTAL	1	12.5	0.4	1	12.5	0.3
Guthierrezia sarothrae						
Class 1	6	75.0	2.6	1	12.5	0.3
TOTAL	6	75.0	2.6	1	12.5	0.3
Purshia tridentata						
Class 1	20	250.0	8.4	42	525.0	11.2
Class 2	1	25.0	0.8	0	0.0	0.0
TOTAL	22	275.0	9.2	42	525.0	11.2
Symphoricarpos oreophilus						
Class 1	6	75.0	2.6	12	150.0	3.2
TOTAL	6	75.0	2.6	12	150.0	3.2
SUCCULENTS						
Opuntia polyacantha						
Class 1	10	125.0	4.2	8	100.0	2.1
TOTAL	10	125.0	4.2	8	100.0	2.1
GRAND TOTAL SITE 1	237	2962.5	100.0	376	4700.0	100.0

Table III-5. IMPORTANCE VALUES* FOR TREES (DBH <10 cm),** SHRUBS AND SUCCULENTS AT SITE 1 (chained pinyon-juniper disturbed site)

Species	Fenced Plot	Open Plot
TREES (Saplings)		
Juniperus osteosperma	11.9	14.6
J. scopulorum	1.9	8.2
Pinus edulis	15.9	23.1
SHRUBS		
Amelanchier alnifolia	7.9	14.8
Artemisia tridentata	135.6	147.8
Cercocarpus montanus	24.6	24.7
Chrysothamnus nauseosus	39.8	13.3
C. viscidiflorus	1.9	1.4
Gutierrezia sarothrae	12.6	1.4
Purshia tridentata	31.0	33.6
Symphoricarpos oreophilus	9.6	10.7
SUCCULENTS		
Opuntia polyacantha	7.3	6.4
TOTALS	300.0	300.0

*Importance value = relative cover + relative frequency + relative density
**DBH = diameter at breast height

Table III-6. PERCENT GROUND COVER IN 1-SQUARE-METER QUADRATS

Site	Herbaceous Plants	Woody Plants <25 cm	Mosses	Crustose Lichen	Foliose and Fruticose Lichen	Litter	Bare Ground	Rockyness	Total
Chained Pinyon-Juniper Dist. Open Plot (1-0)	4	<1	4	1	0	62	29	4	104
Chained Pinyon-Juniper Dist. Fenced Plot (1-F)	5	<1	4	<1	0	63	30	2	104
Chained Pinyon-Juniper Control Open Plot (2-0)	7	<1	7	<1	<1	49	45	0	108
Chained Pinyon-Juniper Control Fenced Plot (2-F)	8	2	1	<1	<1	47	46	0	104
Plateau Sagebrush Open Plot (3-0)	15	2	1	1	0	58	26	5	108
Plateau Sagebrush Fenced Plot (3-F)	17	1	<1	<1	<1	48	39	3	108
Valley Sagebrush Open Plot (4-0)	10	<1	<1	<1	0	58	32	2	102
Valley Sagebrush Fenced Plot (4-F)	9	<1	1	<1	0	50	38	3	101
Pinyon-Juniper Disturbed Open Plot (5-0)	10	4	3	<1	<1	11	75	0	103

Table III-6. (Concluded)

Site	Herbaceous Plants	Woody Plants <25 cm	Mosses	Crustose Lichen	Foliose and Fruticose Lichen	Litter	Bare Ground	Rockyness	Total
Pinyon-Juniper Disturbed Fenced Plot (5-F)	13	<1	3	<1	<1	7	81	0	104
Pinyon-Juniper Control Open Plot (6-0)	3	5	29	<1	0	89	6	<1	133
Pinyon-Juniper Control Fenced Plot (6-F)	5	4	25	<1	0	84	13	<1	131

*Values over 100% result from vertical overlap of two or more components

Table III-7. PERCENT GROUND COVER AND PERCENT COMPOSITION* OF TREES, (DBH <10 cm),** SHRUBS, AND SUCCULENTS AT SITE 2 (chained pinyon-juniper control site)

Species	Fenced Plot		Open Plot	
	Ground Cover	Composition	Ground Cover	Composition
TREES (Saplings)				
Juniperus osteosperma	2.8	30.3	1.3	23.9
Pinus edulis	1.2	12.2	0.8	13.8
SHRUBS				
Amelanchier alnifolia	0.0	0.5	0.2	3.7
Artemisia tridentata	1.1	11.7	0.3	5.5
Cercocarpus montanus	0.4	4.3	0.3	5.5
Chrysothamnus nauseosus	0.6	6.9	2.6	46.7
Purshia tridentata	3.2	34.1	0.0	0.0
Symphoricarpos oreophilus	0.0	0.0	0.0	0.9
TOTALS	9.3	100.0	5.5	100.0

*Percent composition = relative cover
**DBH = diameter at breast height

Table III-8. FREQUENCY OF TREES (DBH <10 cm),* SHRUBS, AND SUCCULENTS AT SITE 2 (chained pinyon-juniper control site)

Species	Fenced Plot		Open Plot	
	Absolute Frequency	Relative Frequency	Absolute Frequency	Relative Frequency
TREES (Saplings)				
Juniperus osteosperma	70	22.6	50	13.4
Pinus edulis	65	21.0	65	17.5
SHRUBS				
Amelanchier alnifolia	30	9.7	20	5.4
Artemisia tridentata	35	11.3	50	13.5
Cercocarpus montanus	10	3.2	25	6.8
Chrysothamnus nauseosus	50	16.1	85	23.0
C. viscidiflorus	5	1.6	5	1.4
Gutierrezia sarothrae	0	0.0	5	1.4
Purshia tridentata	35	11.3	20	5.4
Symphoricarpos oreophilus	0	0.0	10	2.7
SUCCULENTS				
Opuntia polyacantha	10	3.2	35	9.5
TOTALS		100.0		100.0

*DBH = diameter at breast height

Table III-9. DENSITY OF TREES (DBH <10 cm),* SHRUBS, AND SUCCULENTS AT SITE 2
(Chained pinyon-juniper control site)

	Fenced Plot			Open Plot		
	Absolute Density		Relative Density	Absolute Density		Relative Density
	#/Plot	#/Hectare	(%)	#/Plot	#/Hectare	(%)
TREES (Saplings)						
Juniperus osteosperma						
Class 1	16	200.0	11.5	6	75.0	4.9
2	17	212.5	12.2	11	137.5	9.0
TOTAL	33	412.5	23.7	17	212.5	13.9
Pinus edulis						
Class 1	12	150.0	8.6	17	212.5	13.9
2	8	100.0	5.8	6	75.0	4.9
3	3	37.5	2.2	0	0.0	0.0
TOTAL	23	287.5	16.6	23	287.5	18.8
SHRUBS						
Amelanchier alnifolia						
Class 1	6	75.0	4.3	5	62.5	4.1
2	2	25.0	1.4	1	12.5	0.8
TOTAL	8	100.0	5.7	6	75.0	4.9

*DBH = diameter at breast height

Table III-9. (Continued)

	Fenced Plot			Open Plot		
	Absolute Density		Relative Density	Absolute Density		Relative Density
	#/Plot	#/Hectare	(%)	#/Plot	#/Hectare	(%)
Artemisia tridentata						
Class 1	17	212.5	12.2	11	137.5	9.1
Class 2	3	37.5	2.2	4	50.0	3.3
TOTAL	20	250.0	14.4	15	187.5	12.4
Cercocarpus montanus						
Class 1	4	50.0	2.9	2	25.0	1.6
Class 2	0	0.0	0.0	1	12.5	0.8
Class 3	1	12.5	0.7	1	12.5	0.8
TOTAL	5	62.5	3.6	4	50.0	3.2
Chrysothamnus nauseosus						
Class 1	14	175.0	10.1	23	287.5	18.9
Class 2	4	50.0	2.9	6	75.0	4.9
TOTAL	18	225.0	13.0	29	362.5	23.8
C. viscidiflorus						
Class 1	0	0.0	0.0	1	12.5	0.8
TOTAL	0	0.0	0.0	1	12.5	0.8

Table III-9. (Concluded)

	Fenced Plot			Open Plot		
	Absolute Density		Relative Density	Absolute Density		Relative Density
	#/Plot	#/Hectare	(%)	#/Plot	#/Hectare	(%)
Guitierrezia sarothrae						
Class 1	0	0.0	0.0	1	12.5	0.8
TOTAL	0	0.0	0.0	1	12.5	0.8
Purshia tridentata						
Class 1	19	237.5	13.7	7	87.5	5.8
Class 2	9	112.5	7.5	1	12.5	0.8
TOTAL	28	350.0	20.2	8	100.0	6.6
Symphoricarpos oreophilus						
Class 1	0	0.0	0.0	8	100.0	6.6
TOTAL	0	0.0	0.0	8	100.0	6.6
SUCCULENTS						
Opuntia polyacantha						
Class 1	4	50.0	2.9	10	125.0	8.2
TOTAL	4	50.0	2.9	10	125.0	8.2
GRAND TOTAL SITE 2	139	1737.5	100.0	122	1525.0	100.0

Table III-10. IMPORTANCE VALUES* FOR TREES (DBH <10 cm),** SHRUBS, AND SUCCULENTS AT SITE 2 (chained pinyon-juniper control site)

Species	Fenced Plot	Open Plot
TREES (Saplings)		
Juniperus osteosperma	76.7	51.3
Pinus edulis	49.8	50.2
SHRUBS		
Amelanchier alnifolia	15.9	14.0
Artemisia tridentata	37.4	31.3
Cercocarpus montanus	11.1	15.5
Chrysothamnus nauseosus	36.0	93.5
C. viscidiflorus	1.6	2.2
Gutierrezia sarothrae	0.0	2.2
Purshia tridentata	65.4	11.9
Symphoricarpos oreophilus	0.0	10.2
SUCCULENTS		
Opuntia polyacantha	6.1	17.7
TOTALS	300.0	300.0

*Importance value = relative cover + relative frequency + relative density

**DBH = diameter at breast height

Bare ground occupies a greater percentage of the area (45 percent), while litter cover is reduced (48 percent) (Table III-6).

Site 3. Plateau Sagebrush Site. Sagebrush is a conspicuous species in many of the plant communities on the tract, and in some places it assumes an overwhelmingly dominant role. The patchiness of the original woodland vegetation gave rise to openings or large clearings on many of the ridgetops. Originally, these openings may have supported grassland vegetation, but currently these areas are covered by dense stands of big sagebrush. On Tract C-b most of these areas have been chained, but the recovery of the sagebrush has been almost complete, and evidence of damage caused by chaining is minimal.

The plateau sagebrush site is dominated by big sagebrush, which accounts for 95 percent of the shrub cover (Table III-11), 45 percent of the shrub frequency (Table III-12), 94 percent of the shrub density (Table III-13), and 78 percent of the shrub importance value (Table III-14). All of the sagebrush plants on this site are less than 1.5 meters tall. Seven other species occur with big sagebrush, including prickly pear (Opuntia polyacantha), which is the second-ranking species in the community.

Even though sampled late in the season, there was still 16 percent cover by herbaceous species (Table III-6), which is greater than at any other site. Tabulations of these species are forthcoming. Mosses and lichens occur on the site, but they provide very little cover (Table III-6).

Site 4. Valley Sagebrush Site. Big sagebrush also occurs as a dominant species in the alluvial deposits of gulches which cross the tract. Under these valley floor environmental conditions, sagebrush occurs at densities more than twice those for the ridgetop site. Growth of individual plants is also greater in the valleys, where some

Table III-11. PERCENT GROUND COVER AND PERCENT COMPOSITION* OF TREES (DBH <10 cm)** AND SHRUBS AT SITE 3 (plateau sagebrush site)

	Fenced Plot		Open Plot	
	Ground Cover	Composition	Ground Cover	Composition
TREES (Sapling)				
Pinus edulis	0.2	3.7	0.6	5.5
SHRUBS				
Artemisia tridentata	5.2	96.3	10.0	92.6
Chrysothamnus nauseosus	0.0	0.0	0.1	0.9
Gutierrezia sarothrae	0.0	0.0	0.0	0.5
SUCCULENTS				
Opuntia polyacantha	0.0	0.0	0.0	0.5
TOTALS	5.4	100.0	10.7	100.0

*Percent composition = relative cover

**DBH = diameter at breast height

Table III-12. FREQUENCY OF TREES (DBH <10 cm),* SHRUBS, AND SUCCULENTS AT SITE 3 (plateau sagebrush site)

Species	Fenced Plot		Open Plot	
	Absolute Frequency	Relative Frequency	Absolute Frequency	Relative Frequency
TREES (Saplings)				
Juniperus osteosperma	5	2.6	0	0.0
Pinus edulus	15	7.9	35	13.2
SHRUBS				
Amelanchier alnifolia	0	0.0	40	15.1
Artemisia tridentata	100	52.7	100	37.7
Chrysothamnus nauseosus	0	0.0	10	3.8
C. viscidiflorus	0	0.0	5	1.9
Gutierrezia sarothrae	15	7.9	40	15.1
SUCCULENTS				
Opuntia polyacantha	55	28.9	35	13.2
TOTALS		100.0		100.0

*DBH = diameter at breast height

Table III-13. DENSITY OF TREES (DBH <10 cm),* SHRUBS, AND SUCCULENTS AT SITE 3 (plateau sagebrush site)

	Fenced Plot			Open Plot		
	Absolute Density		Relative Density	Absolute Density		Relative Density
	#/Plot	#/Hectare	(%)	#/Plot	#/Hectare	(%)
TREES (Saplings)						
Juniperus osteosperma						
Class 1	1	12.5	0.2	0	0.0	0.0
TOTAL	1	12.5	0.2	0	0.0	0.0
Pinus edulis						
Class 1	2	25.0	0.3	9	112.5	1.3
Class 2	1	12.5	0.2	0	0.0	0.0
TOTAL	3	37.5	0.5	9	112.5	1.3
SHRUBS						
Amelanchier alnifolia						
Class 1	0	0.0	0.0	12	150.0	1.7
TOTAL	0	0.0	0.0	12	150.0	1.7
Artemisia tridentata						
Class 1	564	7050.0	94.6	680	8500.0	94.4
TOTAL	564	7050.0	94.6	680	8500.0	94.4

*DBH = diameter at breast height

Table III-13. (Concluded)

	Fenced Plot			Open Plot		
	Absolute Density		Relative Density	Absolute Density		Relative Density
	#/Plot	#/Hectare	(%)	#/Plot	#/Hectare	(%)
Chrysothamnus nauseosus						
Class 1	0	0.0	0.0	2	25.0	0.3
TOTAL	0	0.0	0.0	2	25.0	0.3
C. viscidiflorus						
Class 1	0	0.0	0.0	1	12.5	0.1
TOTAL	0	0.0	0.0	1	12.5	0.1
Gutierrezia sarothrae						
Class 1	5	62.5	0.8	8	100.0	1.1
TOTAL	5	62.5	0.8	8	100.0	1.1
SUCCULENTS						
Opuntia polyacantha						
Class 1	23	287.5	3.9	8	100.0	1.1
TOTAL	23	287.5	3.9	8	100.0	1.1
GRAND TOTAL SITE 3	596	7450.0	100.0	720	9000.0	100.0

Table III-14. IMPORTANCE VALUES* FOR TREES (DBH <10 cm),** SHRUBS, AND SUCCULENTS AT SITE 3 (plateau sagebrush site)

Species	Fenced Plot	Open Plot
TREES (Saplings)		
Juniperus osteosperma	2.8	0.0
Pinus edulus	12.1	19.9
SHRUBS		
Amelanchier alnifolia	0.0	16.8
Artemisia tridentata	243.6	224.8
Chrysothamnus nauseosus	0.0	5.0
C. viscidiflorus	0.0	2.0
Gutierrezia sarothrae	8.7	16.7
SUCCULENTS		
Opuntia polyacantha	32.8	14.8
TOTALS	300.0	300.0

*Importance value = relative cover + relative frequency + relative density

**DBH = diameter at breast height

plants are greater than 2 meters in height. The valley sagebrush site has low shrub diversity, with only five species growing on the site. Big sagebrush, the dominant species, covers 33 percent of the area (Table III-15) at densities of approximately 20,000 individuals per hectare (2 shrubs/per square meter) (Table III-17). Sagebrush was encountered in every sample, and the only other species which occurs with high frequency is winterfat (Eurotia lanata) (70 percent frequency; Table III-16). The presence of winterfat is one of the most obvious differences between the valley and ridgetop sagebrush sites. As may be expected, big sagebrush accounts for 82 percent of the importance value at the valley sagebrush site (Table III-18).

Herbaceous species cover approximately 10 percent of the understory. Mosses and lichens are present in limited amounts, and litter covers approximately 54 percent of the surface (Table III-6).

Site 5. Pinyon-Juniper Disturbed Site. Pinyon-juniper woodlands are the most widespread vegetation type on the tract and in surrounding areas. The dominant species are pinyon pine, Utah juniper (Juniperus osteosperma), and Rocky Mountain juniper (Juniperus scopulorum). Tree heights on the pinyon-juniper disturbed site ranged from 3 meters (Utah juniper) to 13 meters (pinyon pine) with an average of approximately 6 meters (Figure III-2). Tree diameters ranged from 10 centimeters (4 inches)--the minimum size for a tree, by definition--to 71 centimeters (27.9 inches) (Figure III-3). The average density is about 410 trees per hectare (Table III-19), with Utah juniper the dominant species. (Initial tree data summarization has been completed. Further analysis will be employed to determine structural aspects of the pinyon-juniper woodlands.)

The shrub stratum at site 5 is quite sparse. Total shrub cover is approximately 2 percent (Table III-20), and shrub density is only 624 shrubs per hectare (one shrub per 16 square meters, approximately)

Table III-15. PERCENT GROUND COVER AND PERCENT COMPOSITION* OF SHRUBS AND SUCCULENTS AT SITE 4 (valley sagebrush site)

Species	Fenced Plot		Open Plot	
	Ground Cover	Composition	Ground Cover	Composition
SHRUBS				
Artemisia tridentata	29.6	94.1	36.8	99.2
Eurotia lanata	1.8	5.9	0.1	0.3
SUCCULENTS				
Opuntia polyacantha	0.0	0.0	0.2	0.5
TOTALS	31.4	100.0	37.1	100.0

*Percent composition = relative cover

Table III-16. PERCENT FREQUENCY OF SHRUBS AND SUCCULENTS AT SITE 4 (valley sagebrush site)

Species	Fenced Plot		Open Plot	
	Absolute Frequency	Relative Frequency	Absolute Frequency	Relative Frequency
SHRUBS				
Artemisia tridentata	100	52.7	100	60.6
Chrysothamnus nauseosus	10	5.3	15	9.1
Eurotia lanata	70	36.8	15	9.1
Purshia tridentata	5	2.6	0	0.0
SUCCULENTS				
Opuntia polyacantha	5	2.6	35	21.2
TOTALS		100.0		100.0

Table III-17. DENSITY OF SHRUBS AND SUCCULENTS AT SITE 4
(valley sagebrush site)

	Fenced Plot			Open Plot		
	Absolute Density		Relative Density	Absolute Density		Relative Density
	#/Plot	#/Hectare	(%)	#/Plot	#/Hectare	(%)
SHRUBS						
Artemisia tridentata						
Class 1	930	11,625.0	59.3	1309	1,6361.5	71.4
Class 2	295	3687.5	18.8	355	4437.5	19.4
Class 3	125	1562.5	8.0	136	1700.0	7.4
Class 4	0	0.0	0.0	1	12.5	0.1
TOTAL	1350	16,875.0	86.1	1801	22,512.5	98.3
Chrysothamnus nauseosus						
Class 1	4	50.0	0.2	5	62.5	0.3
TOTAL	4	50.0	0.2	5	62.5	0.3
Eurotia lanata						
Class 1	207	2587.5	13.2	17	212.5	0.9
TOTAL	207	2587.5	13.2	17	212.5	0.9
Purshia tridentata						
Class 1	1	12.5	0.1	0	0.0	0.0
TOTAL	1	12.5	0.1	0	0.0	0.0

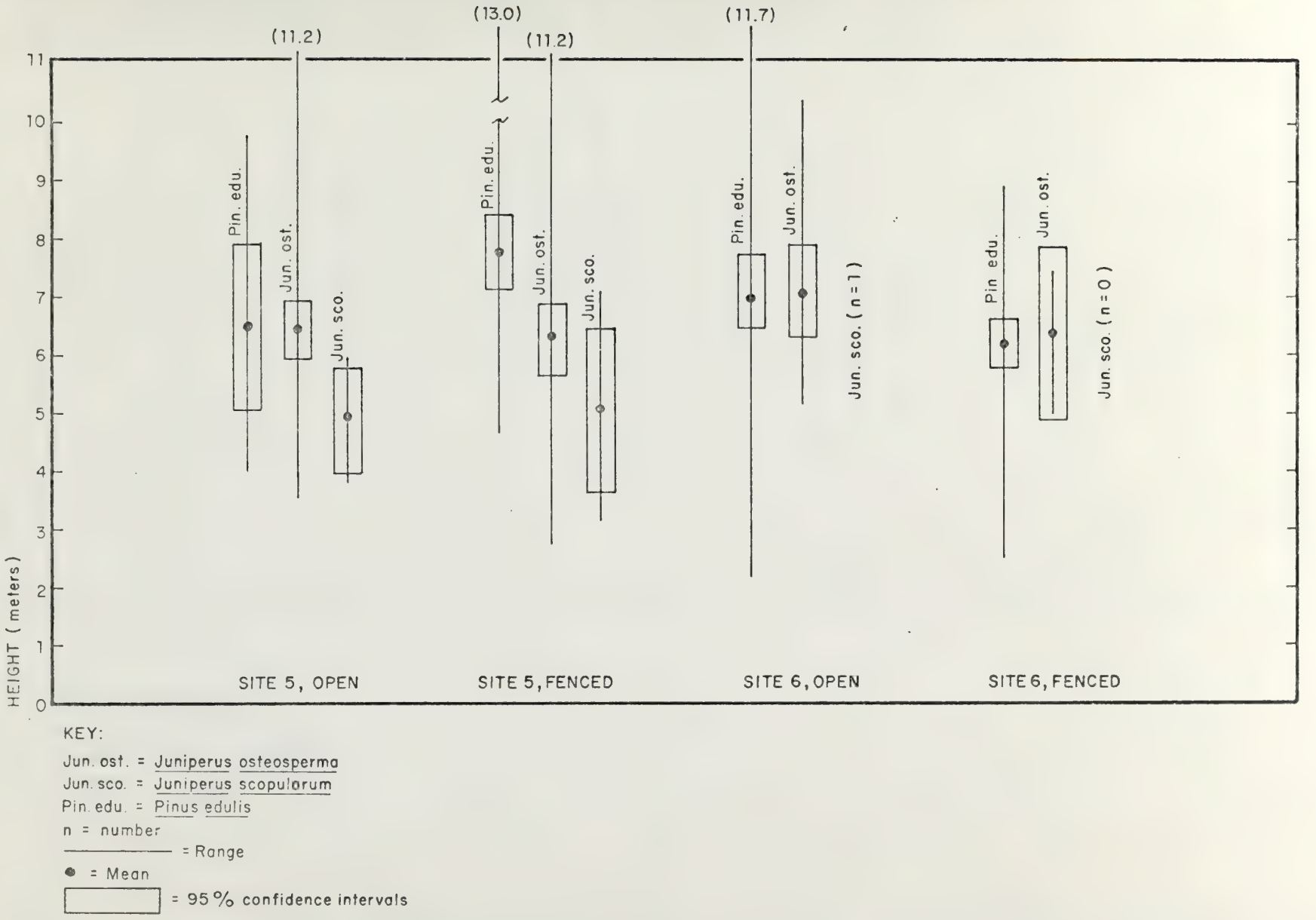
Table III-17. (Concluded)

	Fenced Plot			Open Plot		
	Absolute Density		Relative Density	Absolute Density		Relative Density
	#/Plot	#/Hectare	(%)	#/Plot	#/Hectare	(%)
SUCCULENTS						
Opuntia polyacantha						
Class 1	7	87.5	0.4	10	125.0	0.5
TOTAL	7	87.5	0.4	10	125.0	0.5
GRAND TOTAL SITE 4	1569	19,612.5	100.0	1833	22,912.5	100.0

Table III-18. IMPORTANCE VALUES* FOR SHRUBS AND SUCCULENTS AT SITE 4 (valley sagebrush site)

Species	Fenced Plot	Open Plot
SHRUBS		
Artemisia tridentata	232.8	258.1
Chrysothamnus nauseosus	5.6	9.4
Eurotia lanata	55.9	10.3
Purshia tridentata	2.7	0.0
SUCCULENTS		
Opuntia polyacantha	3.0	22.2
TOTALS	300.0	300.0

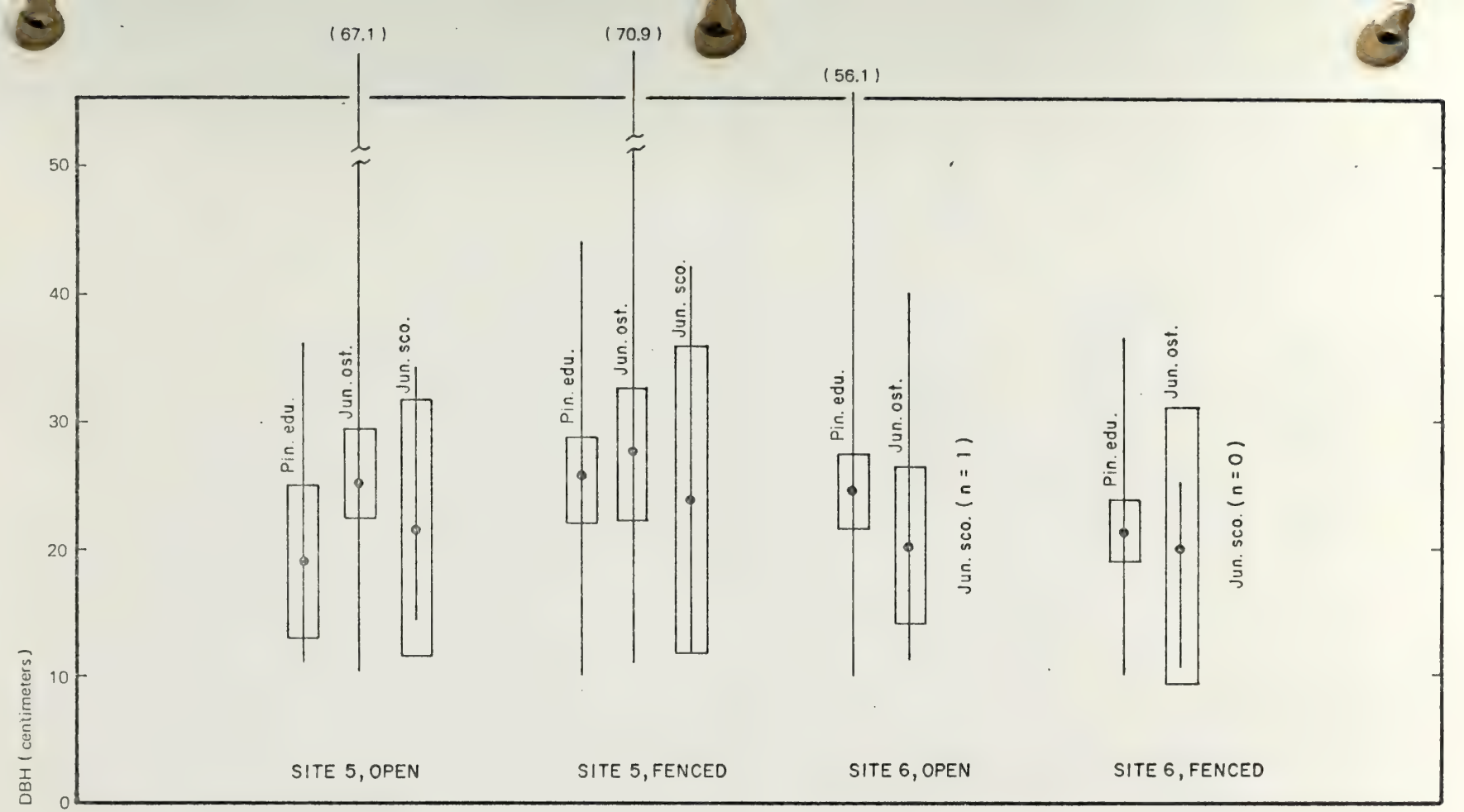
*Importance Value = relative cover and relative frequency and relative density



KEY:

Jun. ost. = Juniperus osteosperma
Jun. sco. = Juniperus scopularum
Pin. edu. = Pinus edulis
n = number
——— = Range
● = Mean
▭ = 95 % confidence intervals

Figure III-2. HEIGHT OF TREES IN VEGETATIVE PLOTS (range, mean, and 95% confidence intervals)



KEY:
DBH = Diameter at breast height
Pin. edu. = Pinus edulis
Jun. ost. = Juniperus osteosperma
Jun. sco. = Juniperus scopulorum
n = number
——— = Range
● = Mean
▭ = 95% confidence intervals

Figure III-3. DIAMETER OF TREES IN VEGETATIVE PLOTS (range, mean, and 95% confidence interval)

Table III-19. DENSITY OF TREES (DBH >10 cm)* AT SITE 5 (pinyon-juniper disturbed site)

Plot	Species	#/Plot	Density/Hectare
5-Open	Pinus edulis	10	62.5
	Juniperus osteosperma	44	275.0
	J. scopulorum	5	31.2
	TOTAL	59	368.7
5-Fenced	Pinus edulis	34	212.5
	Juniperus osteosperma	32	200.0
	J. scopulorum	6	37.5
	TOTAL	72	450.0

*DBH = diameter at breast height

Table III-20. PERCENT GROUND COVER AND PERCENT COMPOSITION* OF TREES (DBH <10 cm)** AND SHRUBS AT SITE 5 (pinyon-juniper disturbed site)

Species	Fenced Plot		Open Plot	
	Ground Cover	Composition	Ground Cover	Composition
TREES (Saplings)				
Pinus edulis	0.2	10.0	1.2	45.1
SHRUBS				
Amelanchier alnifolia	0.2	13.3	0.6	23.5
Artemisia tridentata	0.8	53.4	0.6	25.5
Cercocarpus montanus	0.4	23.3	0.0	0.0
Purshia tridentata	0.0	0.0	0.2	5.9
TOTALS	1.6	100.0	2.6	100.0

*Percent composition = relative cover
**DBH = diameter at breast height

(Table III-22). Big sagebrush, pinyon pine saplings, and serviceberry are the three top-ranking species based on importance value (Table III-23); however, none of the species are very evenly or thickly distributed on the site (Table III-21).

Herbaceous plants cover 11 percent of the understory, but 78 percent of the ground layer is bare of any vegetation (Table III-6). Mosses cover 3 percent of the ground layer, and only a few lichens occur.

Site 6. Pinyon-Juniper Control Site. The pinyon and juniper trees at site 6 are comparable in diameter and height to those at site 5 (Figure III-2 and 3). Tree density (Table III-24) is also comparable to that at site 5, but pinyon pine is the dominant tree. Initial data from the dendrochronology study have shown that some of the trees at site 6 are more than 600 years old.

As at site 5, the shrub layer is quite sparse, with the cover being approximately 2 percent (Table III-25) and density equal to 2262 shrubs per hectare (Table III-27). The dominant shrub is big sagebrush (relative density = 62 percent), with serviceberry and pinyon pine saplings present as secondary shrub dominants (Table III-28). A total of nine woody or succulent species were encountered in the sample (Table III-26). One of the primary differences between sites 5 and 6 is the absence of prickly pear at site 5 and its presence at a density of 426 plants per hectare at site 6.

The herb layers of the two sites are also quite different. Herb cover was only 4 percent at site 6; mosses covered 27 percent of the ground surface; and litter formed a nearly continuous layer (87 percent cover). Bare ground averaged less than 10 percent (Table III-6).

At this point in the discussion it may be appropriate to make a few general comments about these sites and the vegetation types they represent.

Table III-21. PERCENT FREQUENCY OF TREES (DBH <10 cm)* AND SHRUBS AT SITE 5 (pinyon-juniper disturbed site)

Species	Fenced Plot		Open Plot	
	Absolute Frequency	Relative Frequency	Absolute Frequency	Relative Frequency
TREES (Saplings)				
Juniperus osteosperma	5	3.6	25	14.7
J. scopulorum	0	0.0	10	5.9
Pinus edulis	35	25.0	50	29.5
SHRUBS				
Amelanchier alnifolia	20	14.3	50	29.4
Artemisia tridentata	25	17.9	25	14.7
Cercocarpus montanus	30	21.3	5	2.9
Chrysothamnus nauseosus	5	3.6	0	0.0
Purshia tridentata	20	14.3	5	2.9
TOTALS		100.0		100.0

*DBH = diameter at breast height

Table III-22. DENSITY OF TREES (DBH <10 cm)* AND SHRUBS AT SITE 5
(pinyon-juniper disturbed site)

	Fenced Plot			Open Plot		
	Absolute Density		Relative Density	Absolute Density		Relative Density
	#/Plot	#/Hectare	(%)	#/Plot	#/Hectare	(%)
TREES (Saplings)						
Juniper osteosperma						
Class 1	1	12.5	2.0	2	25.0	4.1
Class 2	0	0.0	0.0	1	12.5	2.0
Class 3	0	0.0	0.0	1	12.5	2.0
TOTAL	1	12.5	2.0	4	50.0	8.1
J. scopulorum						
Class 1	0	0.0	0.0	1	12.5	2.0
TOTAL	0	0.0	0.0	1	12.5	2.0
Pinus edulis						
Class 1	9	112.5	17.6	1	12.5	2.0
Class 2	1	12.5	2.0	0	0.0	0.0
TOTAL	10	125.0	19.6	1	12.5	2.0
SHRUBS						
Amelanchier alnifolia						
Class 1	7	87.5	13.7	18	225.0	36.8
TOTAL	7	87.5	13.7	18	225.0	36.8

*DBH = diameter at breast height

Table III-22. (Concluded)

	Fenced Plot			Open Plot		
	Absolute Density		Relative Density	Absolute Density		Relative Density
	#/Plot	#/Hectare	(%)	#/Plot	#/Hectare	(%)
Artemisia tridentata						
Class 1	6	75.0	11.8	20	250.00	40.9
Class 2	2	25.0	3.9	3	37.5	6.2
TOTAL	8	100.0	15.7	23	287.5	47.1
Cercocarpus montanus						
Class 1	11	137.5	21.6	1	12.5	2.0
Class 2	1	12.5	2.0	0	0.0	0.0
TOTAL	12	150.0	23.6	1	12.5	2.0
Chrysothamnus nauseosus						
Class 1	1	12.5	2.0	0	0.0	0.0
TOTAL	1	12.5	2.0	0	0.0	0.0
Purshia tridentata						
Class 1	12	150.0	23.5	1	12.5	2.0
TOTAL	12	150.0	23.5	1	12.5	2.0
GRAND TOTAL SITE 5	51	637.5	100.1	49	612.5	100.0

Table III-23. IMPORTANCE VALUES* FOR TREES (DBH <10 cm)** AND SHRUBS AT SITE 5 (pinyon-juniper disturbed site)

Species	Fenced Plot	Open Plot
TREES (Saplings)		
Juniperus osteosperma	5.6	22.8
J. scopulorum	0.0	7.9
Pinus edulis	54.6	76.5
SHRUBS		
Amelanchier alnifolia	41.3	90.0
Artemisia tridentata	86.8	87.1
Cercocarpus montanus	68.3	4.9
Chrysothamnus nauseosus	5.6	0.0
Purshia tridentata	37.8	10.8
TOTALS	300.0	300.0

*Importance value = relative cover + relative frequency + relative density

**DBH = diameter at breast height

Table III-24. DENSITY OF TREES (DBH >10 cm)* AT SITE 6 (pinyon-juniper control site)

Plot	Species	#/Plot	Density/Hectare
6-Open	Pinus edulis	58	362.5
	Juniperus osteosperma	13	81.2
	J. scopulorum	1	6.3
	TOTAL	72	450.0
6-Fenced	Pinus edulis	42	262.5
	Juniperus osteosperma	4	25.0
	J. scopulorum	0	0.0
	TOTAL	46	287.5

*DBH = diameter at breast height

Table III-25. PERCENT GROUND COVER AND PERCENT COMPOSITION* OF TREES (DBH <10 cm)** SHRUBS, AND SUCCULENTS AT SITE 6 (pinyon-juniper control site)

Species	Fenced Plot		Open Plot	
	Ground Cover	Composition	Ground Cover	Composition
TREES (Saplings)				
Juniperus osteosperma	0.0	2.9	0.0	1.9
Pinus edulis	0.0	0.0	0.3	11.3
SHRUBS				
Amelanchier alnifolia	0.0	0.0	0.4	13.2
Artemisia tridentata	1.6	91.4	1.6	60.4
Chrysothamnus nauseosus	0.0	0.0	0.2	9.4
SUCCULENTS				
Opuntia polyacantha	0.1	5.7	0.1	3.8
TOTALS	1.7	100.0	2.6	100.0

*Percent composition = relative cover
**DBH = diameter at breast height

Table III-26. FREQUENCY OF TREES (DBH <10 cm),* SHRUBS, AND SUCCULENTS AT SITE 6 (Pinyon-juniper control site)

Species	Fenced Plot		Open Plot	
	Absolute Frequency	Relative Frequency	Absolute Frequency	Relative Frequency
TREES (Saplings)				
Juniperus osteosperma	40	16.3	10	4.9
Pinus edulis	45	18.4	20	9.8
SHRUBS				
Amelanchier alnifolia	15	6.1	40	19.5
Artemisia tridentata	80	32.8	70	34.1
Chrysothamnus nauseosus	0	0.0	15	7.3
C. viscidiflorus	5	2.0	0	0.0
Purshia tridentata	5	2.0	0	0.0
Symphoricarpos oreophilus	0	0.0	5	2.4
SUCCULENTS				
Opuntia polyacantha	55	22.4	45	22.0
TOTALS		100.0		100.0

*DBH = diameter at breast height

Table III-27. DENSITY OF TREES (DBH <10 cm),* SHRUBS AND SUCCULENTS AT SITE 6 (Pinyon-juniper control site)

	Fenced Plot			Open Plot		
	Absolute Density		Relative Density	Absolute Density		Relative Density
	#/Plot	#/Hectare	(%)	#/Plot	#/Hectare	(%)
TREES (Saplings)						
Juniperus osteosperma						
Class 1	9	112.5	4.7	2	25.0	1.2
Class 2	3	37.5	1.6	0	0.0	0.0
TOTAL	12	150.0	6.3	2	25.0	1.2
Pinus edulis						
Class 1	8	100.0	4.1	2	25.0	1.2
Class 2	3	37.5	1.6	1	12.5	0.6
Class 4	1	12.5	0.5	0	0.0	0.0
TOTAL	12	150.0	6.2	3	37.5	1.8
SHRUBS						
Amelanchier alnifolia						
Class 1	5	62.5	2.6	15	1 187.5	8.8
Class 2	0	0.0	0.0	1	12.5	0.6
TOTAL	5	62.5	2.6	16	200.0	9.4

*DBH = Diameter at breast height

Tabel III-27. (Continued)

	Fenced Plot			Open Plot		
	Absolute Density		Relative Density	Absolute Density		Relative Density
	#/Plot	#/Hectare	(%)	#/Plot	#/Hectare	(%)
Artemisia tridentata						
Class 1	118	1475.0	61.5	101	1262.5	59.4
Class 2	0	0.0	0.0	4	50.0	2.3
TOTAL	118	1475.0	61.5	105	1312.5	61.7
Chrysothamnus nauseosus						
Class 1	0	0.0	0.0	17	212.5	10.0
TOTAL	0	0.0	0.0	17	212.5	10.0
C. viscidiflorus						
Class 1	1	12.5	0.5	0	0.0	0.0
TOTAL	1	12.5	0.5	0	0.0	0.0
Purshia tridentata						
Class 1	1	12.5	0.5	0	0.0	0.0
TOTAL	1	12.5	0.5	0	0.0	0.0
Symphoricarpos oreophilus						
Class 1	0	0.0	0.0	1	12.5	0.6
TOTAL	0	0.0	0.0	1	12.5	0.6

Table III-27. (Concluded)

	Fenced Plot			Open Plot		
	Absolute Density		Relative Density	Absolute Density		Relative Density
	#/Plot	#/Hectare	(%)	#/Plot	#/Hectare	(%)
SUCCULENTS						
Opuntia polyacantha						
Class 1	43	537.5	22.4	26	325.0	15.3
TOTAL	43	537.5	22.4	26	325.0	15.3
GRAND TOTAL SITE 6	192	2400.0	100.0	170	2125.0	100.0

Table III-28. IMPORTANCE VALUES OF TREES (DBH <10 cm),* SHRUBS, AND SUCCULENTS AT SITE 6 (pinyon-juniper control site)

Species	Fenced Plot	Open Plot
TREES (Saplings)		
Juniperus osteosperma	25.4	8.0
Pinus edulis	24.6	22.9
SHRUBS		
Amelanchier alnifolia	8.7	42.1
Artemisia tridentata	185.8	156.2
Chrysothamnus nauseosus	0.0	26.7
C. viscidiflorus	2.5	0.0
Purshia tridentata	2.5	0.0
Symphoricarpos oreophilus	0.0	3.0
SUCCULENTS		
Opuntia polyacantha	50.5	41.1
TOTALS	300.0	300.0

*DBH = diameter at breast height

Sites 1 and 2 are obviously successional. Chaining has removed the forest cover and returned these sites to nonequilibrium conditions. Similarities in the shrub and herb layers of chained and nonchained sites indicate that disturbances caused by chaining have been concentrated in the upper synusium (homogeneous stratum) of the community and have not caused the same level of imbalance in all community strata.

There is considerable variation within the chained pinyon-juniper woodlands. Sites 1 and 2 have a similarity of only 50 percent based on shrub importance value. The variation is most likely due to several factors, but the most obvious is that prior to chaining there was variation within the existing woodlands (which can be seen by comparing site 5 and 6). Chaining disturbances were most likely not uniform so recovery rates and species would differ according to site. Further sampling of other chained areas will give us greater insight into the extent of variation within this cover type.

The sagebrush communities on the ridgetops and in the valleys present several interesting problems. Examination of stem cross sections from valley sagebrush has shown that the largest shrubs may be 60 to 70 years old, indicating a rather long history of sagebrush vegetation on these sites. The presence of sagebrush individuals in all height classes, as well as old dead fallen stems, suggests community stability with regard to this species. These two observations indicate a valley floor vegetation type in which sagebrush has been the primary component since the late 1800s. Stories related by early settlers and homesteaders state that the vegetation in the draws and valleys was primarily a grassland. If these stories are reliable, then the present dominance of big sagebrush in these are may be a result of grazing pressures from sheep and cattle.

The sagebrush on the ridgetops also poses an interesting problem with regard to original vegetation on these sites. It may be that a long history of grazing has also caused an increase in sagebrush and a decrease in grass cover in these areas. These ridgetop sage communities have the best developed herb layer of any of the sampled communities, which could be the result of a variety of reasons; e.g., it may be a remnant of a former grassland. Additional study in these communities, as well as long-term monitoring of the study plots, should provide some of the necessary data for answering these questions.

Comparison of the similarity of each of the paired plots (Table III-29) shows that there is a high level of similarity between each set of plots (fenced and open at each site). This similarity will be useful in making future comparisons at each site.

Additional Phytosociological Sampling. No other sampling has been conducted to date. Sampling of other communities is planned for the 1975 growing season.

Productivity Studies

No productivity data have been collected to date. These studies will begin prior to the onset of growth in spring of 1975.

Decomposition Studies

We will have initial results from the decomposition studies beginning in 1975. Collections from the litter traps will be analyzed at intervals. The first recovery of decomposition bags will be in late September or October. The only data we have now are the weights of the decomposition samples which were placed in the field in November 1974.

Table III-29. COMMUNITY COMPARISON INDEX (C)* FOR FENCED AND OPEN PLOTS BEFORE FENCING**

Site	C
Site 1 - Chained Pinyon-Juniper Disturbed Site	0.870
Site 2 - Chained Pinyon-Juniper Control Site	0.711
Site 3 - Plateau Sagebrush Site	0.868
Site 4 - Valley Sagebrush Site	0.849
Site 5 - Pinyon-Juniper Disturbed Site	0.681
Site 6 - Pinyon-Juniper Control Site	0.790

*$C = \frac{2w}{A + B}$

**Index is based on shrub importance values.

Phenological Studies

The data collected for the phenology study constitute initial data points that will permit monitoring developmental histories of the marked twigs and shrubs. Initial analyses of these data have been conducted, and means, ranges, and confidence intervals for the three shrub species have been calculated (Figures III-4 through III-6). Substantial variation occurs among the amounts of yearly shoot elongation.

Successional Studies

No specific sampling has been conducted for this portion of the project; however, some comments on succession appear in the Phytosociological Studies section of the report.

Gradient Analyses

To date, we have not constructed any ordination models, nor have we conducted any direct gradient analyses. Initial ordinations will be made using the phytosociological data from the intensive study plots.

CONCLUSIONS

It is difficult at this early time of the study to present conclusions. Some observations mentioned elsewhere in this report may be summarized here.

1. To date, no rare or endangered vascular plant species have been located on Tract C-b.
2. Initial data suggest that there is considerable variation within the chained pinyon-juniper woodland and in the pinyon-juniper woodlands.

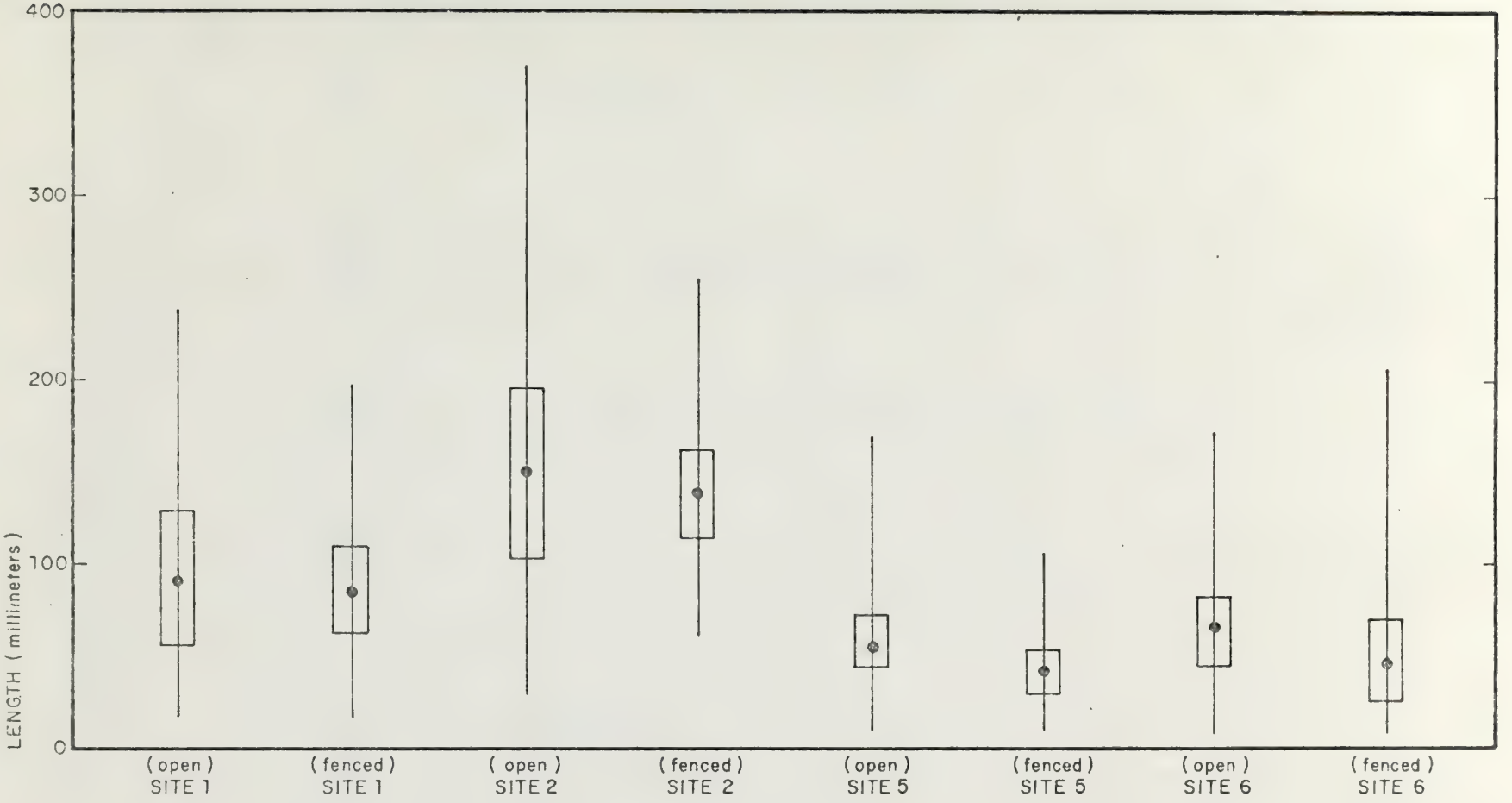


Figure III-4. SHOOT LENGTH OF AMELANCHIER ALNIFOLIA (range, mean, and 95% confidence intervals)

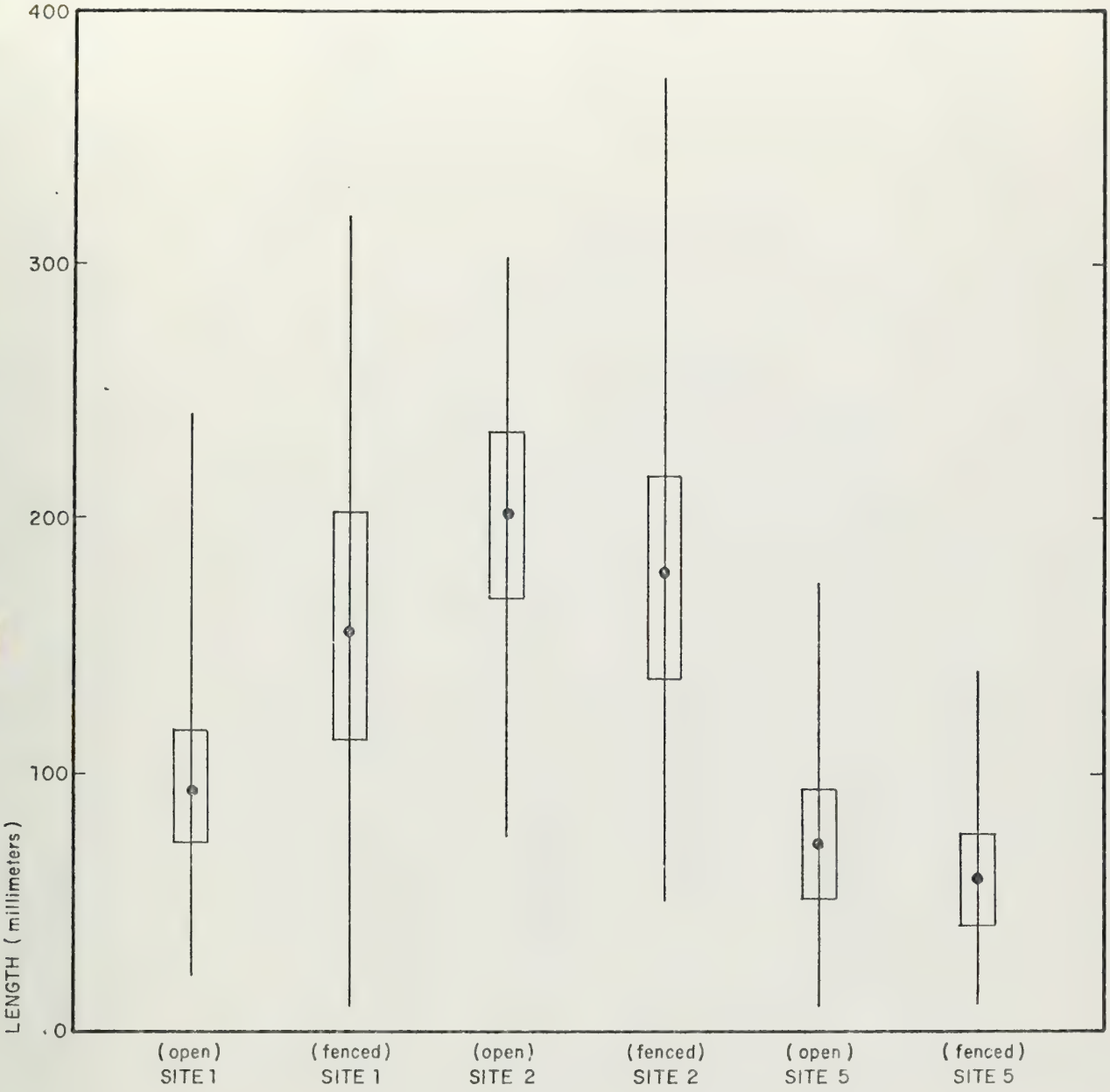


Figure III-5. SHOOT LENGTH OF CERCOCARPUS MONTANUS (range, mean, and 95% confidence intervals)

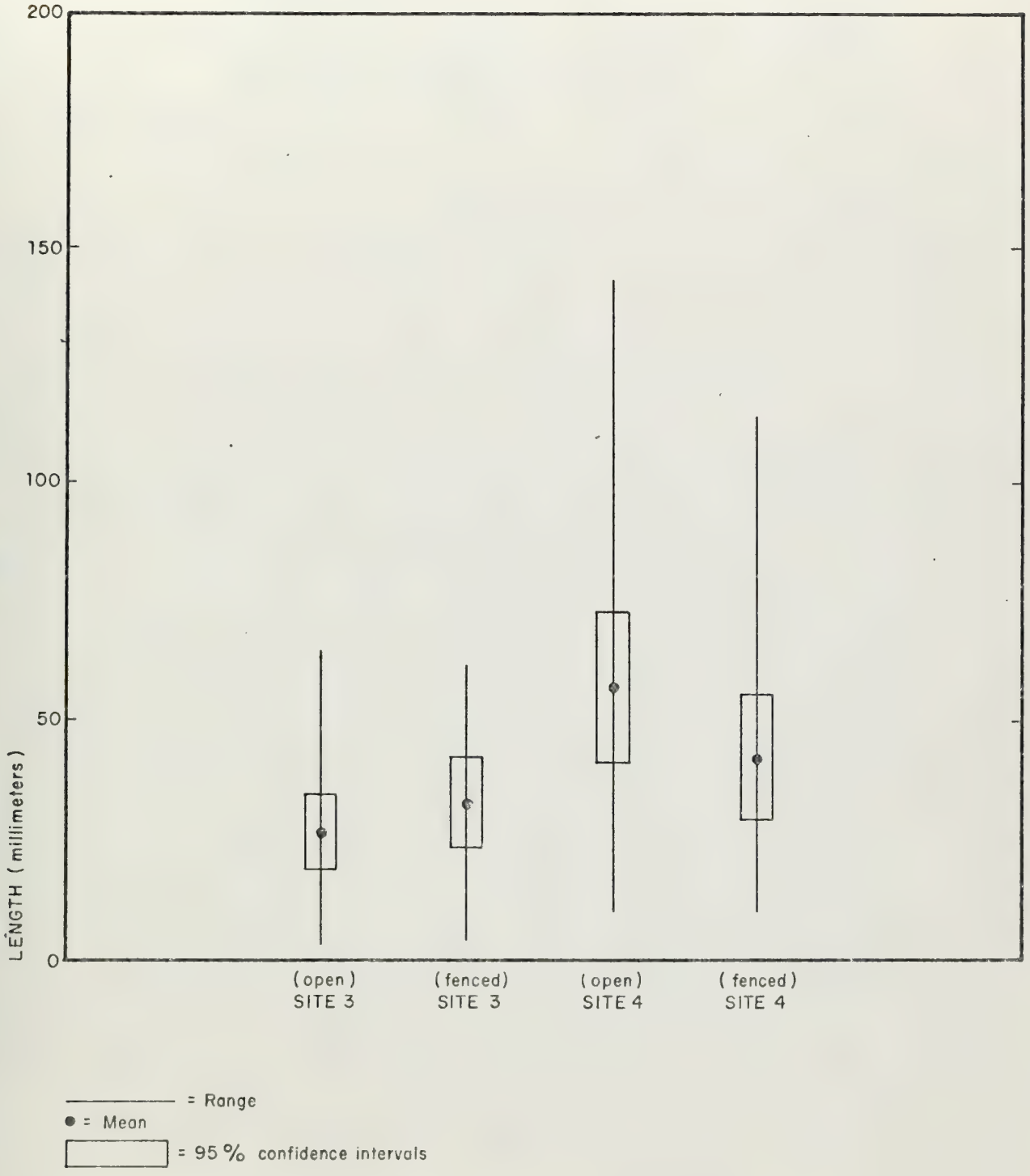


Figure III-6. SHOOT LENGTH OF ARTEMISIA TRIDENTATA (range, mean, and 95% confidence intervals

3. Communities dominated by big sagebrush may have replaced grasslands since the introduction of cattle and sheep in these areas during the homestead days.

4. The fenced and open plots at each site show high similarity to each other, which will allow for meaningful comparison in the future.

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IV

DENDROCHRONOLOGY AND DENDROCLIMATOLOGY

Dendrochronologic and dendroclimatic studies in the Tract C-b area are intended to (1) produce a master chronology that dates the growth increments of pinyon pine (Pinus edulis) for the area, and (2) use climate information and dated growth layers to study variations in past and present climates. The widths of growth rings can serve as natural records of climate when they vary as a function of some limiting environmental factor. In semiarid western Colorado, that limiting factor is precipitation.

The science of dendrochronology and dendroclimatology originated in the semiarid regions of the southwestern United States. Many of the major publications in this field deal with regions in and around the Tract C-b study area (Douglas, 1919, 1928, 1936; Fritts, 1966, 1971; Glock 1937, 1941, 1955; Schulman, 1945, 1956).

METHODOLOGY

Three sampling sites were chosen within the study boundaries of Tract C-b. Stand 1 is located on the crest of the ridge between the West Fork and the Middle Fork of Stewart Gulch at an elevation of 7020 feet. This stand is north of drilling site #17.* Stand 2 is located on the ridge between Willow Creek and Scandard Gulch at an elevation of 6750 feet, and is west of drilling site #9.* Stand 5 is on a

*See Figure 1 of "Pre-Exploration Environmental Reconnaissance: Tract C-b Core Drilling and Associated Groundwater Program," Woodward-Envicon, Inc., July 15, 1974.

south-facing slope along the western bank of Willow Creek at an elevation of 6700 feet. This stand is about one and a half miles south of the junction of Willow and Scandard gulches.

Two sampling sites were selected outside the study boundaries of Tract C-b. Stand 3 is located on the ridge between Hunter Creek and Enoch Gulch at an elevation of 6900 feet. Stand 4 is located on a north-facing slope along the eastern bank of Collins Gulch at an elevation of 6650 feet. It is 3/4 mile north of the Piceance Creek Road.

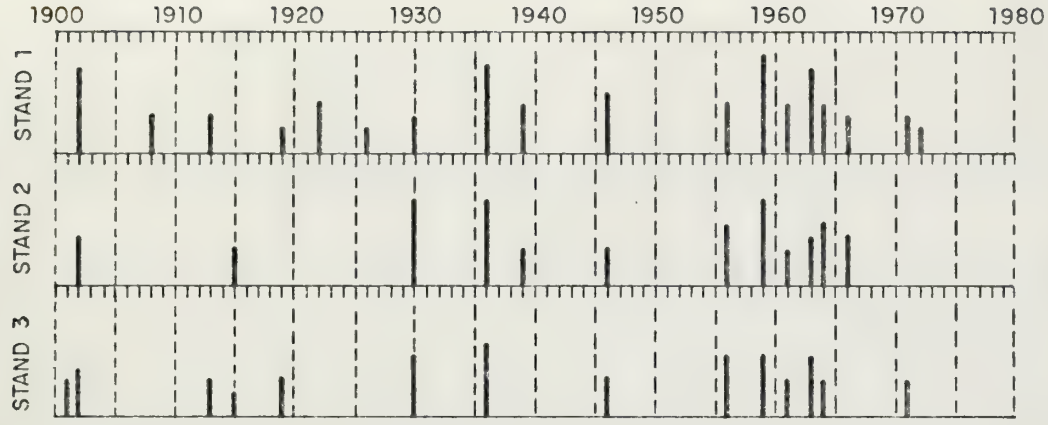
Each stand consisted of eight trees within close proximity. Four cores were taken from each tree at about 4.5 feet above the ground (DBH). The cores were dried in redwood boxes for 10 to 14 days and then mounted in wooden slats for preparation. After the cores were prepared with various grades of sandpaper, number plots and skeleton plots were constructed for each core using the methods detailed by Glock (1937). Missing rings were identified and corrections were made in the skeleton plots.

A composite chronology for each stand was constructed using the corrected skeleton plots. The skeleton plots were compiled and the diagnostic value of each dated growth ring was tabulated. The mean of the diagnostic values for a dated growth layer was incorporated into the composite chronology if it had at least an 80 percent level of occurrence. The dated growth rings were measured to 0.01 millimeter with a standardized ocular micrometer.

RESULTS AND DISCUSSION

Figures 1 and 2 are the composite chronologies for stands 1, 2, and 3.

Dendrochronology and dendroclimatology make use of assumptions that must be clearly explained: the trees selected for sampling are not selected at random, and site selection is very important. Trees are



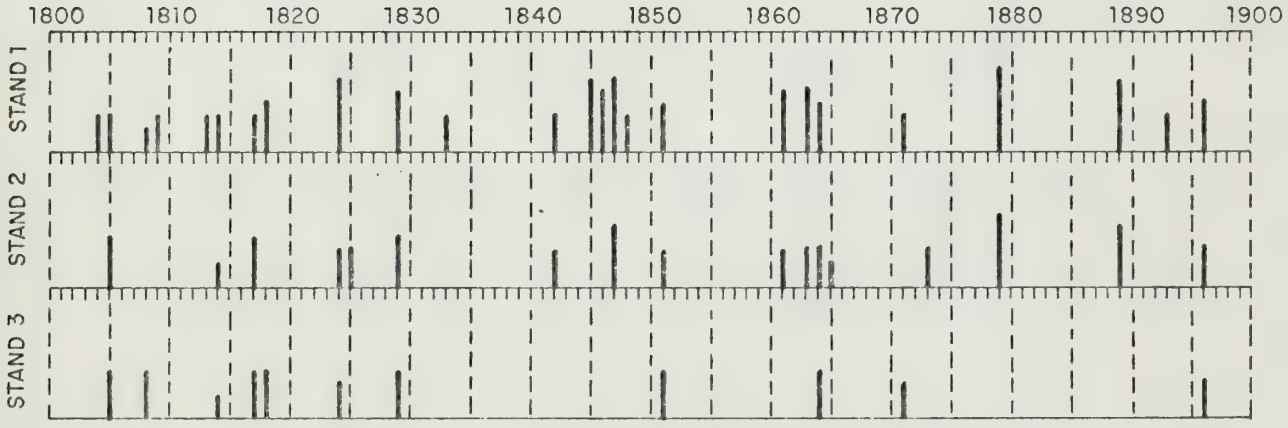


Figure IV-1. COMPOSITE STAND CHRONOLOGIES

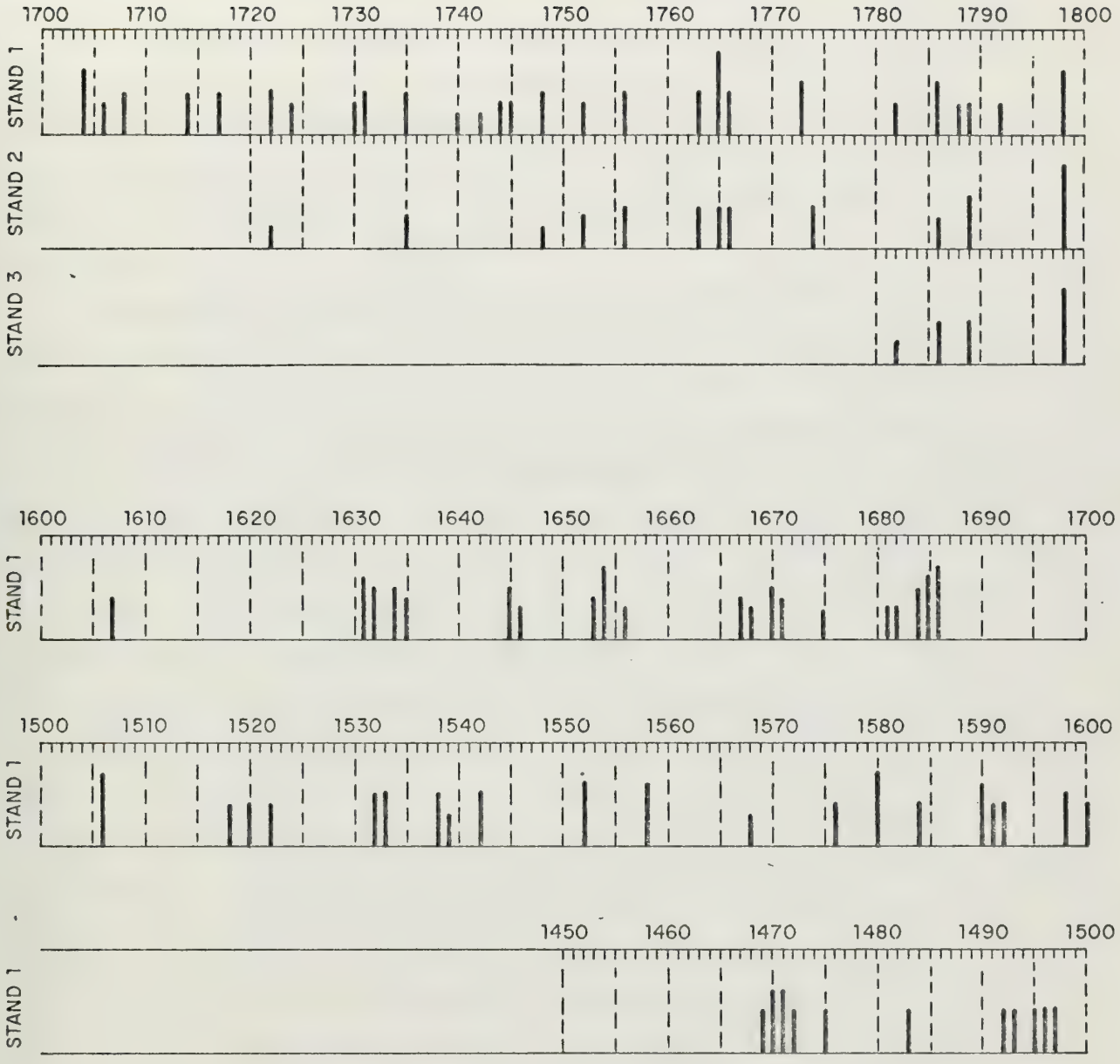


Figure IV-2. COMPOSITE STAND CHRONOLOGIES

selected in locations where it seems clear that the specimens are growing under stressed conditions and their growth is limited by one major environmental factor (precipitation, in this case).

It cannot be assumed that each tree ring represents a single year's growth. Each growth layer from a sample must be compared to other growth layers from different trees. The comparison is made on the basis of relative thickness. This technique is called cross-dating. Two or more ring sequences cross-date when they are synchronous in formation and effectively duplicate each other in whole or in part (Glock, 1937). A chronology is built in this manner.

A chronology is a representation of the relative thinness of each annual growth increment. Each annual increment is compared to its two adjacent growth increments and is rated qualitatively. This rating is visually displayed in the chronology by the use of vertical lines. For any year the height of the line is proportional to the relative thinness of the growth increment; i.e., a tall line indicates a very narrow growth increment, in relation to its neighbors. A short line indicates only a moderately narrow growth increment. Both the height and the interval between lines are important in using a chronology.

Not all of the woody plant species in the study area produce ring sequences that are datable or usable for inferences about climate. The shrub species do not preserve a ring sequence record of sufficient length for dendroclimatology, and often the rings are not clearly recognizable. Utah juniper (Juniperus osteosperma), the codominant with pinyon pine, often produces several growth layers per year, making it unsuitable material. Douglas fir (Pseudotsuga menzesii) would be useful material if it were present in the area in larger numbers and in locations demonstrating greater water stress. Pinyon pine exists throughout the area in places receiving only surficial runoff and it has a sufficiently long tree-ring sequence, both of which make it acceptable material for dendrochronologic and dendroclimatic studies.

Until all five chronologies are completed, nothing can be said regarding the master chronology for the area. A discussion of the past climatic trends must wait until all the tree rings have been measured, statistically analyzed, and finally graphed.

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V

SOILS AND PRODUCTIVITY ASSESSMENT

In November 1974, we received approval from the client to commence the soils and productivity assessment studies.

The studies are designed to satisfy the requirements of the lease stipulations and to provide necessary information about soils to permit the rehabilitation of areas disturbed by the proposed development. In addition, the physical and chemical characteristics of soils in the area planned for spent-shale disposal will be determined.

Before field work can commence, it is necessary to establish soil series and soil types so our classification of Tract C-b and its vicinity will be based on nomenclature compatible with the national soil classification system. We are in contact with the Soil Conservation Service in Glenwood Springs, Colorado, to obtain this information.

Since most of the ground is now either frozen or covered with snow, field work will be delayed until the spring of 1975. It is anticipated that the soils study will be completed about the end of September 1975.

In December, some soils information was obtained at the site to initiate greenhouse studies for determining the productivity of various soil types.

OTHER STUDIES

FISH AND WILDLIFE
MANAGEMENT PLAN

SECTION III A. FISH AND WILDLIFE MANAGEMENT PLAN

The Fish and Wildlife Management Plan is required by the Oil Shale Lease Environmental Stipulations Section 4.

We have developed a draft Program Statement outlining the areas which we feel should be addressed in this Plan. This Program Statement is contained in this section of our Quarterly Report.

At this point in time, we are engaged in internally reaching a decision on personnel who will prepare the Plan. Beginning very early in the next quarter, we expect to begin collecting data which is available from local, state, and federal sources on a historical and Basinwide basis which relates to fish and wildlife species and habitats in the Piceance Basin area. Also, a thorough review will be made of existing plans and developing plans for the management of fish and wildlife and their habitats in the Piceance Basin area. Work will be coordinated with the Energy Impact Wildlife Management Plan Coordination Committee.

As the planning phase begins for the development of Tract C-b, the above data, along with the baseline data now being collected for the Tract area specifically will be utilized in attempting to predict potential areas of impact related to possible development alternatives. Measures for minimizing this impact will be formulated and evaluated during the planning period. Methods for continued evaluation of the success of implementing these mitigation procedures will be devised. Methods for providing alternate habitat in the event it appears any habitat will be unavoidably damaged will be proposed.

The final Plan will be submitted in the Detailed Development Plan.

PROGRAM STATEMENT

FISH AND WILDLIFE MANAGEMENT PLAN

C-b Shale Oil Project

I. Purpose

The aims in formulating the Fish and Wildlife Management Plan are as follows:

A. To at least meet the requirements of the Environmental Stipulations of the Lease, which state that "the Lessee shall submit...a detailed fish and wildlife management plan which shall include the steps which the Lessee shall take to: 1) avoid or, where avoidance is impracticable, minimize damage to fish and wildlife habitat, including water supplies; 2) restore such habitat in the event it is unavoidably destroyed or damaged; 3) provide alternate habitats; and 4) provide controlled access to the public for the enjoyment of the wildlife resources on such lands as may be mutually agreed upon. The plan shall include, but not be limited to, detailed information on activities, time schedule, performance standards, proposed accomplishments, and ways and means of avoiding or minimizing environmental impacts on fish and wildlife."

B. To provide information necessary to be able to meet requirements of the Environmental Stipulations of the Lease concerning mitigation of damage to fish or wildlife habitat, which include the formulation of measures to "avoid, or, where avoidance is impracticable, minimize and repair, injury or destruction of fish and wildlife and their habitat. As a general rule, the proposed measures should provide for habitat of similar type and equal in quantity and quality to that destroyed or damaged."

C. To provide information necessary to determine when and where it may be necessary to construct big game drift fences in the vicinity of the Tract, to direct big game movements around or away from oil shale development areas.

Note: Throughout this Program Statement, the term "Management Plan" as it occurs in the Oil Shale Lease Environmental Stipulations is interpreted as being primarily related to the elimination or minimization to the extent possible and practicable of adverse effects on fish and wildlife which might be caused by the development and operation of oil shale activities and facilities on Tract C-b. Basin-wide and historical data is needed to formulate this Plan,

and effects on Basin-wide populations must be considered, therefore, the Plan must address much more than the acreage of the Tract. However, the Plan is not interpreted as being a "Management Plan" in the traditional sense of the term, in which groups of selected animals are "managed" to produce a specific yield for a specific purpose. It could probably better be called a "Mitigation Plan." Mitigation of harmful effects caused by activity associated with Tract C-b is its primary purpose. Management in the traditional sense is felt to be the province of agencies such as the Division of Wildlife, and the sensible contribution of the C-b Shale Oil Project to this type of management will lie in fully cooperating with these agencies in actively supporting and joining them in carrying out the objectives of their existing or future Management Plans for the Piceance Basin.

II. General Objectives

Objectives in formulating the Fish and Wildlife Management Plan may be considered on two levels, as follows:

A. "Micro" level - on-Tract emphasis

1. Utilizing Basin-wide historical data along with data being obtained in the baseline Aquatic Ecology and Fauna studies of Tract C-b and its immediate surrounding area, analyze the significance of the Tract area with respect to animal use of the Tract and adjacent aquatic habitat.

2. Taking into consideration possible schemes for development of the Tract area and future support facilities, attempt to predict and describe both positive and negative effects of these alternative schemes on fish and wildlife in the Basin.

3. Formulate general policies and several levels of specific procedures which would serve to mitigate any adverse effects which the above development schemes might be predicted to have on fish and wildlife. Give evaluations and descriptions of what, if any, negative impact might remain in the event that each of these levels of mitigation were to be followed. In the case of potential positive effects, formulate procedures to maximize these effects.

4. Delineate any negative effects which might be expected to occur even if the mitigation procedures were followed. Outline plans for providing alternate

habitat or otherwise going to lengths beyond the incorporation of such special design considerations as location of facilities, method of construction, and timing, to eliminate, as much as this is possible, all negative impacts on fish or wildlife which might be caused specifically by the development of Tract C-b. Delineate adverse effects remaining after these special programs are implemented.

B. "Macro" level - Basin-wide considerations

1. Investigate records and historical data which exist for present Terrestrial and Aquatic Wildlife Habitat Areas which include Tract C-b; compile information on aspects of wildlife such as population levels and fluctuations, migratory and other movements, and significant habitats.

2. Formulate general policies and specific procedures which would be effective in possibly mitigating major effects of the total predicted extent of oil shale and other development planned for the region, to be coordinated and implemented in conjunction with government agencies and corporations which are involved in this type of development.

III. Scope

A. Address both aquatic wildlife and terrestrial wildlife.

B. A Plan which will, as much as is possible, address the ecosystem as a whole including all species of wildlife, is ultimately desired. However, the primary initial emphasis will of necessity be on those species of economic importance, endangered or threatened status, rarity, uniqueness, or high aesthetic value. These important species should be considered individually, with other faunal elements of the system initially treated as groups of species.

C. Consider both livestock and wildlife.

D. Consider each of the following major categories:

1. Impact on habitat.

2. Impact on wildlife and livestock populations.

3. Impact on people (recreational use) and effects of people.

4. Effects of development.

E. Address general policies as well as specific procedures; off-Tract as well as on-Tract considerations.

F. Include evaluative procedures to judge the degree of success of mitigative measures.

G. Within the constraints of the Lease and the status of Tract C-b as public land, formulate possible non-development-related policies and procedures which would enhance the status of the Tract as wildlife habitat, especially for the enjoyment of the public, with specific consideration of categories such as:

- public access considerations
- controlled access possibilities during development phase for personnel safety, maintenance of a "quality" experience for hunters and other users, gathering of management evaluation information, etc.
- mass transit possibilities
- public information programs
- poaching problems
- regional planning approaches
- habitat enhancement

H. Coordinate any plans or procedures with any existing Management Plans for the Piceance Basin.

I. Flexibility, as opposed to a rigid program, is desired.

IV. Desired Product

A. Evaluation of Tract C-b (and the surrounding primary sphere of influence of on-Tract development) as a part of the region's wildlife system.

B. Description of potential positive and negative effects in wildlife of specific activities related to planned development and of development in general.

C. List and description of alternatives of policy, planning and design criteria to mitigate adverse effects and enhance positive effects.

D. Evaluation of effectiveness of each of these alternative proposed criteria.

E. List and description of additional, more comprehensive programs which might be undertakin in conjunction with other major off-site development activities, to mitigate broader-ranging negative impacts. Description of effectivenessof these programs with respect to specific wildlife groups.

F. Delineation of methods to monitor and evaluate the effectivenessof these policies and criteria during and after implementation.

G. List and description of wildlife-related recreational and other opportunities for the enhancement of Tract C-b as wildlife habitat for public enjoyment.

H. Delineation of specific areas and methods for cooperation, coordination, and interfacing with government agencies and others involved in fish, wildlife, and livestock management in the Piceance Basin, and including procedures for integration of the Tract C-b Fish and Wildlife Management Plan and other Management Plans in existence for the Piceance Basin area.

V. Probable Methods of Investigation

A. Interviews with personnel of the State Division of Wildlife and other government agencies, both at central offices and local and regional offices, to determine availability of records of data including past population levels, movements, and significant habitats of animals in the Tract C-b area; to obtain recommendations of sources for obtaining this data; and, to obtain advice of those with personal knowledge and experience in the Piceance Basin.

B. Interviews with local citizens and citizen and environmental groups, to gain information and to determine additional areas of concern for consideration in mitigation plans.

C. Interviews with others planning development in the Piceance Basin.

D. Study of basin-wide and historical data available.

E. Study of baseline data being collected on Tract C-b.

F. Field overview trip of reconnaissance level.

G. Familiarization with development alternatives for C-b.

H. Familiarization with general development predictions for the Piceance Basin.

I. Familiarization with any present Management Plans in existence for the Piceance Basin area.

VI. Time Frame

A. The Fish and Wildlife Management Plan must be completed for inclusion with Tract C-b Detailed Development Plan, to be submitted in the Fall of 1975.

B. Specific measures for Mitigation of Damage to fish or wildlife habitat must be submitted to the Mining Supervisor at least 60 days prior to the planned destruction or significant alteration of the habitat. (To the extent that any potential significant disturbance to fish or wildlife habitat taking place in pre-development phases might not be specifically covered in the Fish and Wildlife Management Plan, it will be necessary to formulate a methodology for arriving at these individual Plans for mitigation of damage.)

REVEGETATION STUDIES

SECTION III B

REVEGETATION STUDIES

C-b Shale Oil Project

Quarterly Report

August-November, 1974

The Revegetation Plan for Tract C-b is in the prepatory stage, with initial work to be begun in the Spring of 1975. In the development of our Revegetation Plan we have had the noteable advantage of the extensive revegetation work done by Colony Development Operation. Part of our planning process is the application of Colony Developments' work to the situation on Tract C-b, and the application of other revegetation experiments as well.

Current efforts are being directed at the design of rehabilitation of areas disturbed by exploration activities. Our Revegetation/Rehabilitation work is composed of two phases. The first is aimed at projects of the above scope, the second at the more experimental task of establishing vegetation on processed shale. The working thesis for both of these efforts contains the following major elements: 1) The criteria of erosion control and surface stabilization; support of wildlife; and accommodation of natural successional events; 2) A creative interdisciplinary design which provides for the development and implementation of Revegetation/Rehabilitation practices consistent with advances in the art and with land use practices; and which allows for the application of pertinent biological information gathered during the baseline investigation period.

In formulating the initial activities to be begun in the Spring of 1975, we have utilized an experimental plot on Tract C-b. This surface disturbance plot was established by the Colorado Department of Natural Resources in 1974. An in-house evaluation of species growing in the plot was made during the latter part of 1974. The results of this evaluation (Table 1) have been used to develop a recommended list of species to be used in planting disturbed areas (Table 2).

The Revegetation Plan for Processed Shale rehabilitation is currently in the working outline stage. This plan will be ready in a draft form by the middle of 1975.

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TABLE 1

RESULTS OF EVALUATION OF SURFACE DISTURBANCE PLOTS
(COLORADO DEPARTMENT OF NATURAL RESOURCES) ON TRACT C-b

SPECIES	RATING
Yellow sweetclover	fair*
Thickspike wheatgrass	fair
Palmer penstemon	v. good
Western wheatgrass	fair
Basin wildrye	poor
Alfalfa	poor
Bluegrass	poor
Siberian wheatgrass	good
Mountain brome	good
Burnet	poor
Intermediate wheatgrass	v. good
Crested wheatgrass	good
Skunkbrush	poor
Salina wildrye	poor
Pubescent wheatgrass	v. good
Antelope bitterbrush	fair
Durar hard fescue	fair
Intermediate wheatgrass	v. good
Smooth brome	fair
Alkali sacaton	poor
Indian ricegrass	fair
Bent grass	poor
Gooseberry leaf globemallow	good
Mountain penstemon	fair
Meadow brome	fair
Utah sweetvetch	good
Cliffrose	v. good
Mountain mahogany	fair
Desert bitterbrush	good
Tall wheatgrass	fair
Needle-and-thread grass	good

* Rating Factors

(growth, vigor, stand density)	Very Good
"	Good
"	Fair
"	Poor

TABLE 2

RECOMMENDED SEED LIST FOR SURFACE DISTURBANCE AREAS ON TRACT C-b
(DEVELOPED FROM THE RESULTS SHOWN IN TABLE 1)

GRASSES:	lbs/acre
Agropyron dasystachyum-critana (thickspike wheatgrass)	1
A. desertorum-nordan (crested wheatgrass)	1
A. intermedium - amur (intermediate wheatgrass)	2
A. intermedium - oahe (intermediate wheatgrass)	2
A. smithii (western wheatgrass)	1
A. trachycaulum - primar (slender wheatgrass)	1
A. trichophorum - luna (pubescent wheatgrass)	2
Bromus marginatus (mountain brome)	2
Oryzopsis humenoides (indian ricegrass)	1
Stipa comata (needle-and-thread)	1

FORBS:	lbs/acre
Hedysarum boreale utahensis (Utah sweetvetch)	1/2
Penstemon paleri (palmer penstemon)	1/2
Sphaeralcea grossulariaefolia (gooseberry leaf globemallow)	1/2

SHRUBS:	lbs/acre
Cercocarpus montanus (mountain mahogany)	2
Cowania mexicana stansburiana (stansbury cliffrose)	2
Purshia tridentata (antelope bitterbrush)	2
TOTAL	21 1/2

AERIAL PHOTOGRAPHIC
STUDIES

SECTION III C

MICROENVIRONMENTAL STUDIES

C-b Shale Oil Project

Quarterly Report

August - November, 1974

There are no provisions for Microenvironmental Studies under the Lease or the Lease Environmental Stipulations; nor are there any conditions set by the Area Oil Shale Mining Supervisor's Office.

The Microenvironmental Program is being implemented inorder to obtain data on the physical parameters of the environment. These data will be essential to rehabilitation of the areas impacted by construction and spent shale disposal. The program involves the installation of instrument stations which will record wind speed and direction; free air temperature; litter temperature; soil temperature; relative humidity; soil moisture; evaporation; snow depth, density, and distribution; solar radiation (net); and precipitation. Stations will be established in each major plant community type on Tract C-b: Chained Pinyon-Juniper; Pinyon Juniper; Plateau Sage; and Bottomland Sage. Additional spot check sites have also been established. The satellite or check points are located in order to more adequately assess possible significant microenvironmental differences produced by aspect, exposure, and the physical makeup of the major plant community types.

Microenvironmental Stations have been sited and support equipment has been installed. To date the stations are not fully instrumented and, therefore, are not in operation.

The following is the proposed schedule for implementation of data collection; installation status is also noted.

1. Soil Moisture - Access tubes have been installed in all but three sites. Monthly measurements will begin in January, 1975, and be conducted during each month thereafter.
2. Snow Survey - Survey sites have been located and will be marked for operation during December, 1974. The Survey will run during December, 1974, January, February, March, and April, 1975.
3. Soil Temperature, Litter Temperature, Solar Radiation, Free Air Temperature, Relative Humidity, Evaporation measurement will begin approximately February 1, 1975.

The types of facilities being used for various data collections are shown in the following table:

Data Operation	Monthly Spot Check	Monthly Survey	Continuous Recording
(1) Free Air Temperature			X
(1) Soil Temperature			X
(2) Min-Max Temperature	X		
(5) Soil Moisture		X	
(1) Wind Speed/Direction			X
(3) Relative Humidity			X
(3) Solar Radiation (Net)			X
(5) Snow Depth, Density, Distribution		X	
(2) Evaporation	X		
(4) Precipitation	X		X

(1) At four permanent stations
(2) At ten relocateable sites (potential instrumentation up to 16)
(3) At one site only, permanent station
(4) At four permanent stations and ten relocateable sites
(5) At 12-16 permanent sites (four of these overlap with one)

MICRO-ENVIRONMENTAL STUDIES

SECTION III D

AERIAL PHOTOGRAPHIC STUDIES

C-b Shale Oil Project

Quarterly Report

August - November, 1974

There are no specific conditions put forward in the Lease or the Environmental Lease Stipulations requiring aerial photographic work. The Aerial Photographic Studies are being made to provide the exploration phase of the operation with materials and to aid in monitoring the effects of development on the leased lands. The following programs are affected by these studies:

1. Topographic mapping at various scales and contour intervals.
2. Surficial geology and joint and fracture analysis.
3. Vegetation Mapping
4. Soil Mapping
5. Preliminary site location studies for facilities such as water impoundments, core site locations, pipelines, plant sites, mine access sites, and roads.

To date, the following materials have been generated using aerial photography:

1. One aerial flight using color, color oblique, color infrared, and black and white films at a negative scale of 1:6000 (1"=500'). Index maps have also been prepared.
2. Orthophotomosaic maps at a scale of 1:6000 (prepared from aerial photographs).

The scope of the Aerial Photographic Studies is as follows: For the first year of baseline studies, aerial flights will be made three times. One flight will be made during the peak of the growing season, one during the early end of the growing season, and one during winter. The types of films used for these flights will vary depending on the field conditions during different parts of the year and other developmental judgements.

The next aerial flight will be made in February, 1975. This flight will record the area of the Tract and one mile outside the perimeter.

ARCHAEOLOGICAL STUDIES

SECTION III E. ARCHAEOLOGICAL STUDIES

The Environmental Stipulations of the Oil Shale Lease require that "the Lessee shall, prior to construction or mining, conduct a thorough and professional investigation of any portion of the Leased lands to be used, including, but not limited to, those to be used for mining, processing, or disposal operations or roads, for objects of historic or scientific interest, including, but not limited to, Indian ruins, pictographs, and other archaeological remains".

An archaeological team has completed a study to determine the level of archaeological or historic significance of Tract C-b. Because of a desire by the Mining Supervisor's office that the report of the results of these investigations be subjected to peer review prior to finalization, the final report is not yet available. Included in this Quarterly Report are the data sheets from this study, and the report interpreting their significance will be included in the next Quarterly Report.

In addition to this survey of representative areas of the Tract to determine significance levels of the area, under our program of Pre-exploration Environmental Reconnaissance studies, every individual area which is proposed to be disturbed during exploration phase activities such as corehole drilling, road improvement, etc. is inspected by a qualified archaeologist for any archaeological significance, and work is not commenced until clearance is received from the archaeologist.

The results of the archaeological survey of Tract C-b are the following: three previously unknown sites were located on the Tract. These sites, in association with two others adjacent to the Tract constitute the known resource of the area. The sites are not seen as being of particularly great significance on either the national or regional level. The lack of significance is based on the comparison of the C-b Tract's resources with those of other portions of the Piceance Basin where site densities were found to be higher and most sites showed evidence of more intensive occupation than was the case on the C-b Tract. The differences in occupational intensity cannot readily be explained from the data derived from this study. No sites were found which would be considered as eligible for nomination to the National Register of Historic ~~Sites~~ Places.

ARCHAEOLOGICAL SURVEY OF COLORADO
INVENTORY SHEET

White River-
Piceance Creek-

Site No 5RB67, Rio Blanco County, Colorado State Stewart Gulch Drainage

1. Prior No/Name PB 73-96 Used By CSU Regional Oil Shale Study

2. Elevation 2024 m. 3. Jessup Gulch 7½ min U.S.G.S. Quad 4. Other Map

5. LOCATION On the east side of Middle Fork of Stewart Gulch at the base of the eastern wall of the shallow canyon. The site is about 30 m. so. of prominent tributary. U.T.M. Grid 4,407,120 N. 242,150 E.
NW¼, NE¼ SEC. 21 TOWNSHIP 5S, RANGE 96W

6. Owner 7. Address

8. Tenant 9. Prior Owner(s)

10. Informant None 11. Address N/A

12. NEAREST WATER Middle Fork, Stewart Gulch permanent ____, season XXXX

13. Distance to 12 91 m. 14. Elevation of 12 2017 m.

15. LOCALE VEGETATION Rabbit brush, Sage, Grasses, Pinyon, Juniper

16. SITE TYPE Hist. Archit. 17. Cultural Affiliation (if known) Euro-american

18. Description The site consists of a single room cabin and a collarsed dug-out about 20 m. east of the road up the Middle Fork. The structures are on the southern edge of an alluvial fan spreading from a seasonal tributary of the Middle Fork. There is a thin scatter of historic trash and an abandoned irrigation ditch also on the site. A corral is located about 50 m. north of the site.

19. Size 50 m. in diam. 20. Faces to (cardinal direction) Northwest

21. Depth & Character of Deposits Alluvial gravel and fines with fines in the preponderant majority. As indicated above the dposits are transported materials whose source is apparently the ridge to the east of the site. Depth of at least 5 m.

22. Material Observed or Reported Stack of fence poles, 1955 Chevrolet, Pick-up truck tailgate, 2 coil bed spring sets, tin cans, broken window glass, and nails.

23. Material Collected None

24. Condition Roof of cabin is bowed, windows broken, door broken.

25. RECOMMENDATIONS None. This site is too recent to be of any value in understanding local history. Also the site has probably been disturbed by hunters who have evidentally been using the site as a camp.

26. Photograph Nos. None 27. Recorded By C. Holder, D. Hall

28 Date 7/9/73

SEND TO — Office of the State Archaeologist
5-A Ketchum Hall
University of Colorado
Boulder, Colorado 80302

SEE REVERSE & CONTINUATION SHEET Nos. ____

Site No. 5RB367, Rio Blanco County, Colo. State Stewart Gulch Drainage NW¼ SEC 21, T. 5S, R. 96W. Page 1 of 2

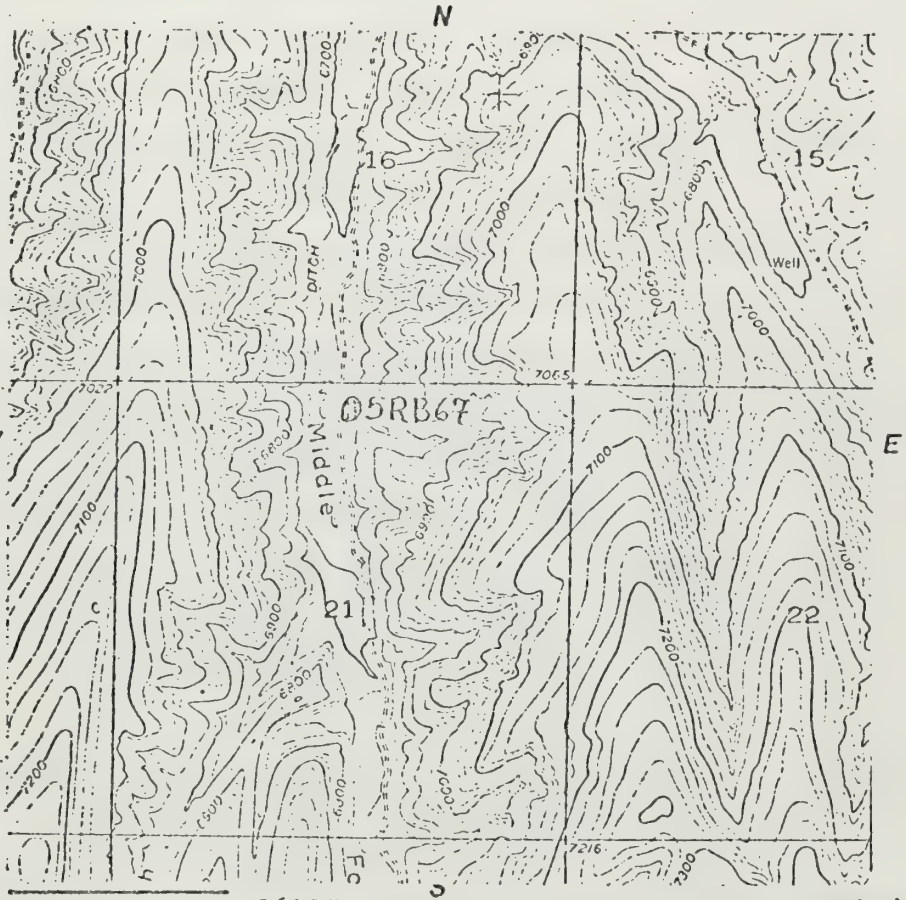
Middle Fork

Sketch Map of Location

Site No 5RB67

NW¼, NE¼ Section 21, Township 3S, Range 96W.

Indicate the chief topographic features, such as streams and elevations. Also indicate houses and roads. Enclose the site area with dotted line. If possible, show extent and kinds of vegetation and sources of other natural resources which may have influenced site selection. Attach a Xerox of portion of U.S.G.S. quadrangle map showing site location, if possible.



SCALE 1 block = 2600' (if diagram does not equal a section)

Directions to site: From the intersection of Piceance Creek Road and Colo. Highway 13 and 789 drive northwestward on Picenace Creek Road about 17.4 mi. and turn south (left) on the main Stewart Gulch road. Travel south 2.4 mi., staying to the left at the junction of Stewart Gulch and the West Fork; which is the junction of the East and Middle Fork roads. Here turn right and proceed south along the Middle Fork about 1.6 mi. to the site.

ARCHAEOLOGICAL SURVEY OF COLORADO
INVENTORY SHEET

Site No 5RB69, Rio Blanco County, Colorado State, Piceance Creek White River-Drainage

1. Prior No./Name PB 73-98 Used By CSU Regional Oil Shale Study

2. Elevation 1932 m. 3. Gulch 7½ min Jessup U.S.G.S. Quad 4. Other Map

5. LOCATION On terrace rim overlooking Piceance Creek flood plain from the south. The spot is about 350 m. east-southeast of the confluence of Piceance and Willow Creeks and about 40 m. north of the main access road to the Cb Oil Shale lease tract. U.T.M. Grid 4,415,400 N. 734,350 E.
, NW¼, NW¼ SEC. 36 TOWNSHIP 2S, RANGE 97W

6. Owner 7. Address

8. Tenant 9. Prior Owner(s)

10. Informant None 11. Address N/A

12. NEAREST WATER Piceance Creek permanent xxx, season

13. Distance to 12 75 m. 14. Elevation of 12 1905 m.

15. LOCALE VEGETATION Juniper, Sage, Rabbit brush, Grasses

16. SITE TYPE Open Chipping 17. Cultural Affiliation (if known)

18. Description Extremely thin scatter of flakes on the rim (norther edge) of the first terrace above the Piceance Creek flood plain. The area is slightly dissected by a minor arroyo flowing northward into Piceance Creek. There has also been considerable disturbance of the surface by cattle but there is no evidence of disturbance of the subsurface deposits by construction or plowing.

19. Size 120 m x 45 m 20. Faces to (cardinal direction) North

21. Depth & Character of Deposits Depth is indeterminate. Deposits consists of gravels and fines with the coarser materials dominant on the face and rim of the terrace and the fines dominant south of the rim. There is no evidence of deeply buried cultural material.

22. Material Observed or Reported See below.

23. Material Collected Flakes, mano. Collection made at random from whole site area. It is likely that all of the cultural material present on the surface of the site at the time of collection was recovered. A re-visit to the site produced no more material.

24. Condition Surface slightly disturbed by livestock. Some erosional dist.

25. RECOMMENDATIONS None. This site shows no potential for improving our knowledge of the prehistory of the area.

26. Photograph Nos.

27. Recorded By C.H. Jennings

28 Date 7/10/74

SEE REVERSE & CONTINUATION SHEET Nos.

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University of Colorado
Boulder, Colorado 80302

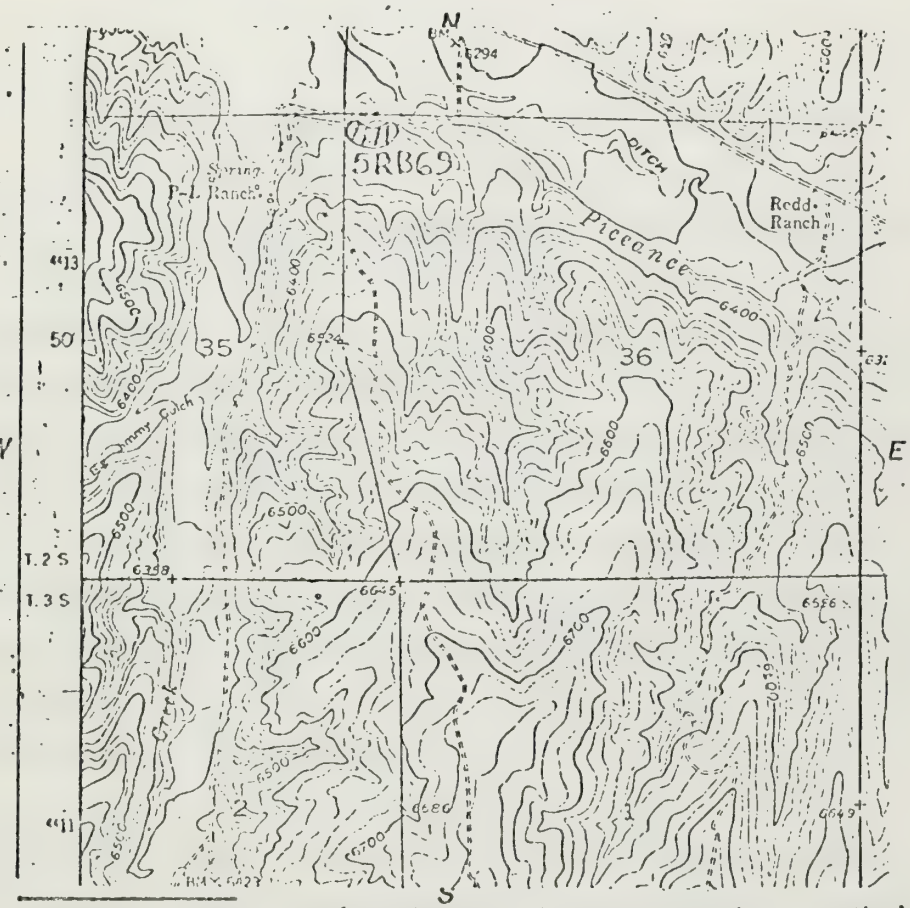
Site No 5RB69, Rio Blanco County, Colo. State, Piceance Cr. Drainage, NW¼ SEC 5, T 2S, R 97W, Page 1 of 2

Sketch Map of Location

Site No. 5RB69

NW¼, NW¼ Section 6, Township 2S, Range 97W.

Indicate the chief topographic features, such as streams and elevations. Also indicate houses and roads. Enclose the site area with dotted line. If possible, show extent and kinds of vegetation and sources of other natural resources which may have influenced site selection. Attach a Xerox of portion of U.S.G.S. quadrangle map showing site location, if possible.



SCALE 1 block = 2600 (if diagram does not equal a section)

Directions to site: Drive northwestward from the junction of Colorado Highway 13 and 789 and Piceance Creek Road along the latter for approximately 20.8 mi. This spot is the junction of the access road to the PL Ranch and Piceance Creek Road. Turn south (left) and cross Piceance Creek.; Stay to the left at the next junction and travel up to the top of the terrace. The site is located north of the road at roughly the point where it turns back to the south after travelling along the terrace in a westerly direction for a distance of about 0.1 mi.

ARCHAEOLOGICAL SURVEY OF COLORADO
INVENTORY SHEET

Site No. 5RB136, Rio Blanco County, Colorado State, Stewart Culch Drainage: White River-Piceance Creek-

1. Prior No./Name None Used By

2. Elevation 2054 m. 3. Jessup Gulch USGS Quad 4. Other Map

5. LOCATION Ca. 0.8 mi. SSE of confluence of Collins Gulch and Piceance Creek atop the ridge between Sorghum and Stewart Gulches. Ca. 0.7 SSW of Oldland Ranch. U.T.M. Grid 4,410,950 m N 740,450 m E , NE¼SW¼ of SEC. 5 TOWNSHIP 3S , RANGE 96W

6. Owner Public Domain 7. Address

8. Tenant 9. Prior Owner(s)

10. Informant 11. Address

12. NEAREST WATER Stewart Gulch permanent XXX , season

13. Distance to 12 1320 m. 14. Elevation of 12 1950 m.

15. LOCALE VEGETATION Pinyon, juniper, opuntia, Indian Rice Grass

16. SITE TYPE Open chipping 17. Cultural Affiliation (if known)

18. Description Sparse scatter of flakes along ridge top in moderately dense pinyon-juniper stand. Truck trail passes west of visible protion of the site. There is a modern trash pile near the southern end of the site.

19. Size 30 m x 10 m 20. Faces to (cardinal direction) East

21. Depth & Character of Deposits Sandy residual from Evacuation Creek s/s. Bedrock outcrops on eastern edge of site. Quite likely very little depth.

22. Material Observed or Reported Tin cans, broken bottles, scattered flakes, burned bone fragments.

23. Material Collected Flakes, burned bone.

24. Condition Slightly disturbed by truck trail but otherwise evidently in good condition.

25. RECOMMENDATIONS Site should be extensively tested and/or systematically surface collected if it is endangered by development. Measures should also be taken to protect it from vandalism but it should not be nominated to the National Register.

26. Photograph Nos. None 27. Recorded By C.H. Jennings, A.P. McNamara

28 Date 7/20/74

SEE REVERSE & CONTINUATION SHEET Nos. None

SEND TO — Office of the State Archaeologist
5-A Ketchum Hall
University of Colorado
Boulder, Colorado 80302

Site No. / County, / State / Drainage / SEC , T , R , Page 1 of

Sketch Map of Location

Site No. 5RB136

NE¼SW¼ Section 5, Township 3S, Range 96W

Indicate the chief topographic features, such as streams and elevations. Also indicate houses and roads. Enclose the site area with dotted line. If possible, show extent and kinds of vegetation and sources of other natural resources which may have influenced site selection. Attach a Xerox of portion of U.S.G.S. quadrangle map showing site location, if possible.

SCALE 1 block = (if diagram does not equal a section)

Directions to site: Turn off Piceance Creek Road at Willow Creek access road (18.8 mi. northwest of Rio Blanco). Take Cb tract access on south side of Stay left at the first two junctions on the tract access road. Drive 5.3 mi. from Piceance Creek Road to Core Hole 7 access road. Turn left (north) on to Core Hole 7 road and drive 2.65 mi. to barbed wire fence. Site is ca. 0.1 mi. further north along the truck trail and is concentrated on the right (east) side of the road.

ARCHAEOLOGICAL SURVEY OF COLORADO
INVENTORY SHEET

Site No. 5RB146, Rio Blanco County, Colorado State, White River-Piceance Creek-Stewart Gulch Drainage

1. Prior No./Name None Used By

2. Elevation 2066 m. 3. Jessup Gulch U.S.G.S. Quad 4 Other Map

5. LOCATION On ridgetop ca. 730 m. SW of confluence of Stewart Gulch and its West Fork and about 520 m. S of Core Hole Cb-5.

U.T.M. Grid 4,410,420 m. N 730,400 m. E

SE¼-SW¼ of SEC. 5 TOWNSHIP 2 S, RANGE 96 W

6. Owner Public Domain 7. Address

8. Tenant 9. Prior Owner(s)

10. Informant None 11. Address

12. NEAREST WATER Stewart Gulch permanent xxxx, season

13. Distance to 12 730 m. 14. Elevation of 12 1950 m.

15. LOCALE VEGETATION Pinyon, Juniper, sage, prickly pear, grasses

16. SITE TYPE Open chipping 17. Cultural Affiliation (if known)

18. Description Thin scatter of cultural material in area around quarter section monument. Much of the site area has been chained. No evidence of fire pits or other features.

19. Size Ca. 800 m^2 20. Faces to (cardinal direction) Northeast.

21. Depth & Character of Deposits Sandy soil with scattered fragments of sandstone. Depth indeterminate but there are no outcrops of the bedrock on the site.

22. Material Observed or Reported Waste flakes

23. Material Collected Waste flakes, two projectile points, scraper fragment.

24. Condition Partly destroyed by chaining of pinyon-juniper cover.

25. RECOMMENDATIONS Site should be protected where it remains undisturbed and should be test excavated if directly endangered by future development of the tract. The site should not be nominated to the National Register.

26. Photograph Nos. None 27. Recorded By D.A. Weber, A.D. Vollmann

28 Date August 5, 1974

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5-A Ketchum Hall
University of Colorado
Boulder, Colorado 80302

SEE REVERSE & CONTINUATION SHEET Nos.

Site No. 5RB146, Rio Blanco County, Colo. State. Stewart Gl. Drainage. SW¼SW¼, SEC. 5, T. 2S, R. 96W. Page 1 of 2

Sketch Map of Location

Site No 5RB146

SE¼SW¼ Section 5, Township 3S, Range 96W

Indicate the chief topographic features, such as streams and elevations. Also indicate houses and roads. Enclose the site area with dotted line. If possible, show extent and kinds of vegetation and sources of other natural resources which may have influenced site selection. Attach a Xerox of portion of U.S.G.S. quadrangle map showing site location, if possible.

SCALE 1 block = 2600' (if diagram does not equal a section)

Directions to site: Take Colorado Hwy. 13 & 789 to Rio Blanco, turn west on to Piceance Creek Road and drive 20.8 mi. to the Willow Creek and PL Ranch Road which is also the main access road to the Cb tract. Drive 0.3 mi. to first junction and stay left and continue ca. 4.1 mi. to SG-6 road; stay to right and drive another 1.4 mi. to SG-7 road and then turn left. Drive down SG-7 road ca. 1.9 mi. to boundary between Sec. 5 and 8. Site is located east of the road in the copse of trees and north in the chained area.

ARCHAEOLOGICAL SURVEY OF COLORADO
INVENTORY SHEET

Site No 5RB147, Rio Blanco County, Colorado State Scandard Gulch Drainage White River, Piceance Cr., Willow Creek,

1. Prior No./Name _____ Used By _____

2. Elevation 2006 m. 3. Jessup Gulch U.S.G.S. Quad 4. Other Map _____

5. LOCATION Southeast of Evacuation Creek s/s outcrop on ridge which is in turn southeast of the confluence of Willow Cr. and Scandard Gulch. .34 mi. south of (con't) SW¼SE¼ of SEC. 2 TOWNSHIP 3S, RANGE 97W U.T.M. Grid 4,410,500 m N 752,870 m E

6. Owner Public Domain 7. Address _____

8. Tenant _____ 9. Prior Owner(s) _____

10. Informant _____ 11. Address _____

12. NEAREST WATER Willow Creek permanent XXX, season _____

13. Distance to 12 230 m 14. Elevation of 12 1954 m.

15. LOCALE VEGETATION Pinyon, juniper, sage, prickly pear, grasses

16. SITE TYPE Open Chipping 17. Cultural Affiliation (if known) _____

18. Description Scattered flakes at base of s/s outcrop which commands an excellent view of Willow Creek and the ridge east of Scandard Gulch. Chained trees have undoubtedly covered a good percentage of the site.

19. Size 21 m x 34 m. 20. Faces to (cardinal direction) Southeast

21. Depth & Character of Deposits Sandy residual material from weathered Evacuation Creek s/s. Depth may run to excess of 50 cm.

22. Material Observed or Reported Scattered flakes.

23. Material Collected 5 flakes, 1 fragment of biface of black chert

24. Condition Path used by livestock crosses site and it has been chained over much of its area.

25. RECOMMENDATIONS Test in undisturbed areas if site is endangered. Site should not be nominated to National Register.

26. Photograph Nos. None 27. Recorded By Donna C. Daniels, Morris Anderson.

28 Date 8/7/74

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5-A Ketchum Hall
University of Colorado
Boulder, Colorado 80302

SEE REVERSE & CONTINUATION SHEET Nos. 1

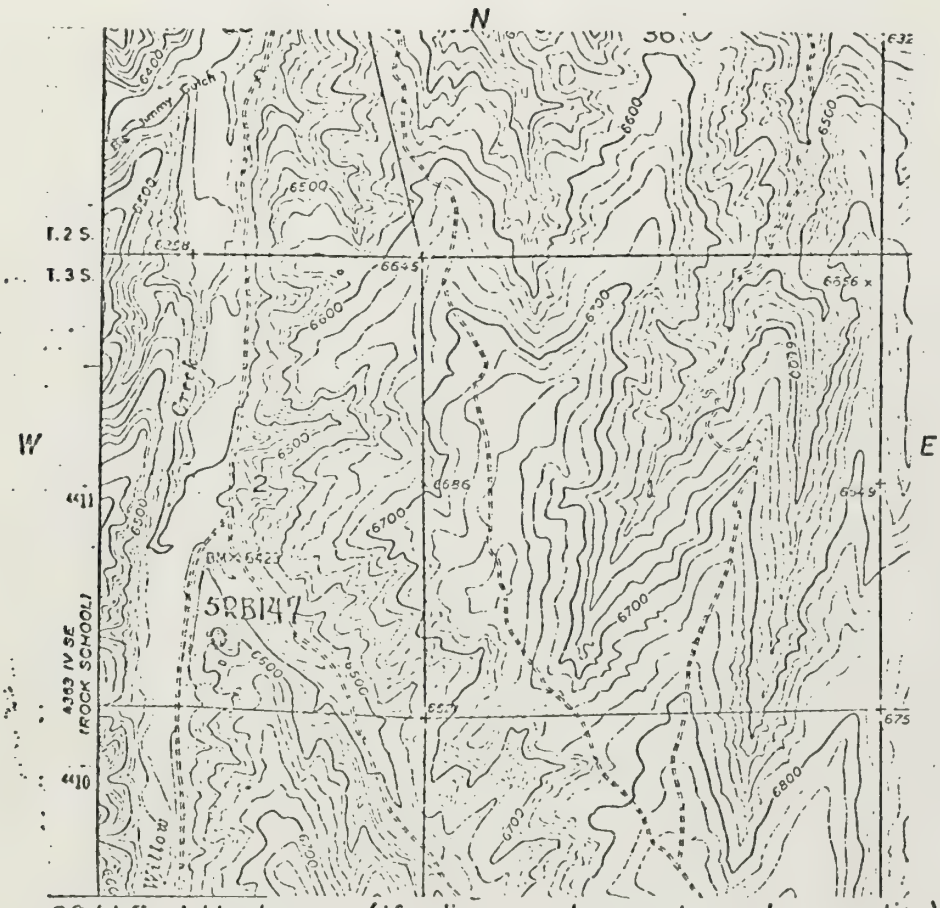
Site No 5RB147, Rio Blanco County, Colo. State Scandard Gl. Drainage SW¼SE¼ SEC. 2, T. 3S., R. 97W. Page 1 of 2

Sketch Map of Location

Site No 5RB147

SW¼SE¼ Section 2, Township 3S, Range 97W

Indicate the chief topographic features, such as streams and elevations. Also indicate houses and roads. Enclose the site area with dotted line. If possible, show extent and kinds of vegetation and sources of other natural resources which may have influenced site selection. Attach a Xerox of portion of U.S.G.S. quadrangle map showing site location, if possible.



SCALE 1 block = (if diagram does not equal a section)

Directions to site: From Rio Blanco go northwest on Piceance Creek Road 18.8 miles. Turn right on the PL Ranch road and travel 0.5 mi. south, take west (right) fork and travel another 0.3 mi. to PL Ranch buildings and turn to south (left). Go 1.3 mi. south to intersection of Willow Creek and Scandard Gulch roads. The site is atop the ridge which faces into the confluence of the two drainages.

ARCHAEOLOGICAL SURVEY OF COLORADO
CONTINUATION SHEET

Site No. 5RB147

ITEM No.	COMMENT
5	the intersection of the Scandard Gulch and the Willow Creek roads.

Site No. 5RB147 1st CONTINUATION SHEET.

Recorded by D.C. Daniels, M.R. Anderson

Date 8/7/74

SEE REVERSE

SCENIC
VALUES STUDY

SECTION III F. SCENIC VALUES PROGRAM

Section 12 of the Oil Shale Lease Environmental Stipulations requires that the Lessee take into consideration existing aesthetic values in all planning, construction, reclamation and mining operations. All operations are required to be performed so as to minimize visual impact, make use of the natural topography, and to achieve harmony with the landscape.

In order to meet these requirements, the type and quality of scenic resources which exist in the Tract C-b area, as well as the relationship of these to the overall scenic resources of the surrounding area are being considered. This effort will cover all seasons, with the bulk of the work probably taking place during the next two quarters.

This program will be correlated with the development planning phase for the Tract, so that planned development alternatives may be evaluated as to their aesthetic impact, and recommendations may be made to minimize any potentially adverse scenic impact.

A photographic history of the Tract, which is an ongoing project, will provide documentation of changes in the visual resources of the area.